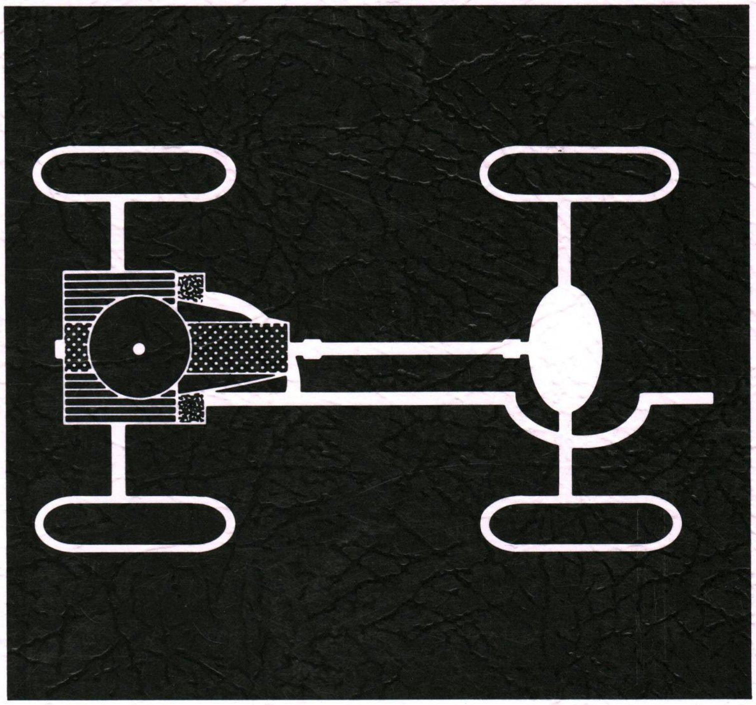
Noise, Vibration, and Harshness



Ford Parts and Service Division
Technical Training

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

As you read through the procedures, you will come across NOTES, CAUTIONS, AND WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind your head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

The recommendations and suggestions contained in this manual are made to assist the dealer in improving his dealership parts and/or service department operations. These recommendations and suggestions do not supersede or override the provisions of the Warranty and Policy Manual or the Shop Manual and in any cases where there may be a conflict, the provisions of the Warranty and Policy Manual or the Shop Manual shall govern.

The descriptions, testing procedures, and specifications in this handbook were in effect at the time the handbook was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design, or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents, if available, may be used. The right is reserved to make changes at any time without notice.

WARNING: Many brake linings contain asbestos fibers. When working on brake components, avoid breathing the dust. Breathing the asbestos dust can cause asbestosis and cancer.

Breathing asbestos dust is harmful to your health.

Dust and dirt present on car wheel brake and clutch assemblies may contain asbestos fibers that are hazardous to your health when made airborne by cleaning with compressed air or by dry brushing.

Wheel brake assemblies and clutch facings should be cleaned using a vacuum cleaner recommended for use with asbestos fibers. Dust and dirt should be disposed of in a manner that prevents dust exposure, such as sealed bags. The bag must be labeled per OSHA instructions and the trash hauler notified as to the contents of the bag.

If a vacuum bag suitable for asbestos is not available, cleaning should be done wet. If dust generation is still possible, technicians should wear government approved toxic dust purifying respirators.

OSHA requires areas where asbestos dust generation is possible to be isolated and posted with warning signs. Only technicians concerned with performing brake or clutch service should be present in the area.

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TABLE OF CONTENTS

INTRODUCTION 1

Objectives 1

Dealing with Noise, Vibration and Harshness 1

DIAGNOSTIC THEORY 2

DIAGNOSTIC PROCEDURE 3

How to Use Diagnostic Procedures 3

Noise Acceptability 3

NVH Diagnosis 3

Road Test 3

Noise 4

Vibration 4

Typical Low Speed Vibration 4

Typical High Speed Vibration 4

Harshness 4

High Speed Shake 5

Tip-in Moan 5

Driveline Vibration 5

Driveline Vibration Incorrect Driveline Angle 5

Engine or Accessory Vibration 5

Vehicle Harshness 5

WHEELS AND TIRES 6

Static Balance 6

Dynamic Balance 7

Effects of Tire Inflation 7

Check for Radial Runout 8

Check for Lateral Runout 8

Correction of Excessive Radial and Lateral Runout of Tire and Wheel 8

WHEEL BEARINGS 9

Wheel Bearing Roughness 9

Isolating Bearing Noise 9

Wheel Bearing Adjustment - Dana Full Floating Rear Axle 9

Wheel Bearing Adjustment - Ford Full Floating Rear Axle 10

BRAKES 11

Front Disc Brake Rotor or Rear Axle Shaft Flange Runout 11

Brake Drum Balance 12

DRIVELINE 13

Driveline Vibration 13

Balance 14

Acceleration/Deceleration Shudder (Driveline Angle) 16

TABLE OF CONTENTS

Two-Piece Driveshafts 18
Driveline Angles 19
Insulator Compression 19
Slip-Joint 20
Intermediate U-Joint 20
Driveshaft Balancing 20
Runout Checks 21
Double Cardan U-Joints 21
Analysis of Gear Noise 22
Axle Shaft End Play Check (Integral Axle) 23
Axle Noise 25
SUSPENSION SYSTEMS 26
Air Suspension 26
Automatic Leveling Suspension 27
Programmed Ride Control 28
STEERING SYSTEMS 29
Steering System Diagnosis 29
ENGINE ACCESSORIES 32
Engine Run-Up Test 32
Engine Accessory Check 32
ENGINE MOUNTS AND EXHAUST SYSTEMS 34
Engine Mounts 34
Exhaust System 35
Body Mounts 35
FRONT-WHEEL DRIVE 36
Isolating Vibration 36
Diagnosis 37
FOUR-WHEEL DRIVE 38
Front Hubs 38
Fluid Contamination 38
WIND NOISES 39
BODY MOUNTS 42
REFERENCE SECTION 43
GLOSSARY OF TERMS 44
NVH WORKSHEET 47
DIAGNOSTIC LOCATOR INDEX 49
Unitized Body, Rear Wheel Drive Car 49
Non-Unitized Body, Car 50
Light Truck 51
Unitized Body, Front Wheel Drive Car 52

INTRODUCTION

OBJECTIVES

This handbook is designed to help you understand the nature of a customer complaint that deals with vehicle noises, vibrations and harshness. The objectives of the program are to improve mechanical skills, to increase the accuracy of diagnosis and to provide time-saving procedures for the identification and elimination of these problems.

This book will present not only specific repair procedures, but a set of diagnostic guidelines. These guidelines are useful in helping you "think" your way through a repair. It will encourage you to rely on your own experiences and knowledge of the various automotive systems, and to make use of the Diagnostic Procedure and Diagnostic Theory. The proper use of the Shop Manual, TSB's, OASIS and IVLS will also be stressed.

DEALING WITH NOISE, VIBRATION AND HARSHNESS

Owners look for and expect prestige, style, ride and comfort in both passenger cars and light trucks. Customers place such high priority on these qualities that they are nearly as important as whether or not the vehicle starts every time. Even light trucks must be treated as though they were luxury vehicles. It is because of this that the Ford Motor Company places special emphasis on the correction of NVH problems.

In many cases problem diagnosis and repair procedures are the same for both passenger cars and light trucks. Therefore, the diagnosis and repair of both types of vehicle are presented in this manual.

The purpose of this publication is to assist the repair technician in resolving NVH concerns in the least amount of time but with the highest degree of accuracy. Diagnostic and repair procedures are presented in a step-by-step format so you can quickly isolate problem areas that are generating the NVH concern. The Diagnostic Theory has been developed to help you to take full advantage of your own knowledge and automotive experience.

To further emphasize the proper use of the Shop Manual, and other related training programs and publications, a reference section has been added to help guide you to TSB's, OASIS, IVLS or other information resources.

DIAGNOSTIC THEORY

Diagnosis is more than just following a series of steps in order to determine the cause of a specific condition. It is a way of looking at systems that are not functioning properly and then finding out why. It is also knowing how a system should work when functioning properly.

There are some basic rules of diagnosis that all good diagnosticians use, whether they're aware of it or not. If you follow these rules, you will find the cause of the condition, usually on the first time through the system.

1. Follow a Fixed Sequence of Diagnosis.

The fastest way to pinpoint the source of a problem is to first eliminate the "obvious" and then move on systematically until the source of the problem is uncovered. This is called working from the "outside-in."

By following a systematic process of elimination, you can be fairly confident that your diagnosis is accurate. A "hit-or-miss" approach will eventually find the problem, but by following a fixed sequence of diagnosis, the chances of a "miss" are greatly reduced. Also, once diagnosis has been made, only make one repair at a time. Working on more than one system at the same time may bring on other problems!

2. Know the System You're Working On.

This means knowing how all the parts go together, knowing how the system operates and what its limits are, and what to expect when something goes wrong. Sometimes this means looking at a system that's working correctly and checking it against the one you're working on.

3. Know the History of the System.

How old is the system? What sort of treatment has it had? Has it been serviced in the past for a condition that may be related to the current problem? What is its service history? A clue in any of these areas might save a lot of diagnosis time for you.

4. Know the Odds of Certain Conditions Developing.

It is true that most conditions are caused by simple things rather than complex ones — and that they occur in a fairly predictable pattern. Electrical problems, for instance, usually occur at connections rather than on components. An engine "no-start" is more likely to be caused by a loose wire or a dead battery. Make sure you know the difference between "impossible" and "improbable." Many a good technician has spent countless hours diagnosing a problem because he decided a potential source of the condition was "impossible."

Also remember that just because a part is new, it doesn't necessarily mean that it's good. New parts are just that: new. Don't overlook them in your diagnosis!

5. Don't Cure the Symptom and Leave the Cause.

Installing a new battery will cure a dead battery situation, just as lowering the air pressure in a front tire may correct a lean to one side. However, these corrections are not necessarily "cures." In the case of the battery, it may have actually been bad, or it may not have taken a charge because the alternator went bad instead. In either case, the "cure" won't last! When the battery runs down again, or the tire loses more air, the customer will be back! Make sure you find the reason the part went bad in the first place.

6. Be Positive You Have Found the Cause.

Know beyond any uncertainty that you found the cause of the problem. Also double-check your work to rule out the possibility that another condition may have contributed to the failure of the part you just replaced. Ask yourself "why did this part go bad?" If one engine mount is loose, what about the other? What about the transmission mounts? Build a picture in your mind of the relationship between the affected part(s) and the rest of the system.

7. Recheck Your Work.

Always recheck your work by taking the vehicle on a road test when repairs have been completed to be sure the condition has been corrected. Remember, never try to correct more than one condition at a time. If a vehicle does have more than one problem, repair one and test it for a solution before attempting to correct the other concern.

DIAGNOSTIC PROCEDURE

No matter what form diagnosis may take, it is simply a way of expressing the relationship between basic logic and a physical system of components. It is a way of letting you "corner" the cause of a condition in the shortest possible amount of time. Diagnosis procedures combine many aspects of diagnosis into an organized approach to problem-solving. These aspects of diagnosis include:

- PROBABILITY of certain components, or functions, before others.
- SIMPLICITY of performing certain tests before others.
- ELIMINATION of checking huge portions of a system by performing simple tests.
- CERTAINTY of narrowing down the search to a small portion before performing in-depth testing.

HOW TO USE DIAGNOSTIC PROCEDURES

This publication is designed to give a working knowledge of the process of diagnosing noise and vibration situations. The road test section will tell how to sort out the conditions into categories and how to tell a vibration from a shake. It will give a few hints on quick checks to make sure that either a cause is pinpointed or eliminated.

Become familiar with the terms. Use the glossary section to find the descriptive name of conditions not encountered before. After naming it, proceed to the section that best identifies the condition, and locate the proper diagnosis section. Remember: just by beginning at a particular point, most of the other systems in the vehicle have been eliminated. When the proper section is identified, the job is partly done. Follow the steps within the section. Make notes along the way to allow reading of important findings.

NOISE ACCEPTABILITY

A gear-driven unit, especially an automotive drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions: for example, tire noise on a newly paved blacktop road. Such noise is in no way detrimental to the operation of the vehicle and must be considered normal. Similarly, camshaft belt whine, most often associated with new belts used on the smaller engines, will usually go away after belt break-in. Also, Traction-Lok axles may produce a slight chatter on slow turns after extended highway driving, which means nothing more than the limited-slip function is working the way it's supposed to.

NVH DIAGNOSIS

NVH diagnosis starts with the customer interview. The service writer must get as much information as possible about the problem and, if possible, take a test drive with the customer, to minimize confusion arising from descriptive language differences. The history of the problem must be investigated: When was it first noticed? Did it appear suddenly or gradually? Did any abnormal occurrence coincide with or precede its appearance (such as pot hole or curb impacts, minor collisions, etc.)? Were any service procedures performed or parts replaced? It is also necessary to know any special conditions affecting the appearance and degree of the problem, such as road speed, drive mode, engine temperature, ambient temperature, etc.

A gradual appearance of the problem indicates a deterioration of a component, such as tires, U-joints, an accessory drive belt, or a wheel bearing.

A sudden appearance of the problem could indicate a lost wheel balance weight, frozen U-joint or lost driveshaft balance weight.

NOTE: INFORMATION GAINED FROM THE PROBLEM DESCRIPTION SHOULD NEVER BE USED IN PLACE OF FACTS GAINED FROM DIAGNOSIS, NOR SHOULD IT BE USED AS AN ATTEMPTED SHORT-CUT FIX. IN THE LONG RUN, TIME WILL BE SAVED BY ADHERING TO THE DIAGNOSTIC PROCEDURES SHOWN.

ROAD TEST

After reviewing the customer interview, the road test will provide much of the information that will allow you to identify the condition you are dealing with, steering you to the correct starting point for diagnosis.

NOTE: ALWAYS USE A TACHOMETER IN ROAD TESTING AND RECORD ENGINE RPM AS WELL AS ROAD SPEED FOR CONDITIONS NOTED.

The following information outlines procedures that should be carried out for the road test.

1. Make notes throughout diagnosis routine. It will help cover all the bases when starting to add up the clues. Use a form (similar to the one shown on page 47) that includes space for comments. Make sure to write down even the smallest bit of information; it may turn out to be most important.

2. Perform the road test checks to bring out the problem condition. This will identify the proper section of the diagnosis procedure. Run through the check procedure more than once to make sure you are getting a useable result.

Remember: The road test checks may not always tell where the problem is, but they will often eliminate other unnecessary checking for you.

3. Do not touch or repair anything until a road test and a thorough visual inspection of the vehicle have been performed. Leave the tire pressures and vehicle load just where they were when the customer brought the vehicle in. Adjusting tire pressures, vehicle load, or making some other seemingly innocent adjustment may reduce the item's intensity to a point where it cannot be identified clearly; it may also inject something new into the system that the customer was not even aware of, preventing proper diagnosis. Make a visual inspection as part of the preliminary diagnosis routine, writing down anything that does not look right. Note tire pressures, but do not adjust them yet. Note leaking fluids, loose nuts and/or bolts, or bright spots where components may be rubbing against each other. Check the trunk or cargo area for unusual loads or damage.

NOTE: IT IS IMPORTANT THAT REAR AXLE NOISE ON VEHICLES EQUIPPED WITH EITHER A MANUAL OR AUTOMATIC OVERDRIVE TRANSMISSION BE EVALUATED IN DIRECT RATHER THAN OVERDRIVE.

NOISE

Noise, defined as any unpleasant sound, may be described in a variety of ways such as tapping, whistling, buzzing, humming, clunking or booming. You can associate these various descriptions of noise with a probable cause. Based on experience, these descriptions will assist in isolating the problem and correcting it. Generally recognizable problem areas are engine, driveline, wind and road surface noises. Other less obvious areas that should be considered as noise problem sources are any of the problems that cause the vibrations described in the following section.

VIBRATION

Vibration, technically, is a high-frequency trembling, shaking or grounding condition, felt or heard, that is constant or variable in level and occurs during a portion of the total operating speed range. The types of vibrations that can be felt in the vehicle can be divided into two groups:

TYPICAL LOW SPEED VIBRATIONS (Less Than 80 km/h or 50 mph)

- Exhaust vibration
- Engine harshness
- Improper driveline angles
- Power steering pump disturbances
- Air conditioner compressor or belt drive vibrations
- Take-off shudder
- Brake roughness or harshness
- Driveline roughness
- Clutch torsion vibration
- Tire bounce

TYPICAL HIGH-SPEED VIBRATIONS (Above 80 km/h or 50 mph)

- Excessive tire-wheel and drum assembly imbalance
- Excessive tire and wheel runout
- Tire roughness due to high non-uniformity (force variation, low speed)
- Companion flange runout or imbalance
- Driveshaft imbalance noise
- Rear axle pinion gear pitch line runout
- Galled, dirty, rusty, worn or improperly lubricated driveline slip yoke splines or U-joint bearings
- Worn suspension components

HARSHNESS

Harshness is the term commonly used to describe the ride quality of the vehicle. Hard ride or harshness is usually caused by the tires or suspension system, namely:

- Over-inflated, wrong size or wrong-type tire installed on the vehicle
- Suspension not sufficiently lubricated
- Worn suspension components
- Suspension components installed with preload on pivot points, bearings and bushings
- Units equipped with tires not specified by the manufacturer. (Different brand tires often give different ride qualities to the vehicle)
- Bent or bound-up shock absorbers
- Heavy-duty components installed on vehicle
- Improper insulation of body or cab mounting (grounding)

DIAGNOSTIC PROCEDURE

HIGH SPEED SHAKE (56 Km/h 35 MPH+)

- Visible shake or pumping feel in steering column, seats or floor pan
- Low frequency vibration 9-15 cycles per second
- Visible front sheet metal shake
- May intensify with light brake application
- Tires, wheels or hubs are likely causes

TIP-IN MOAN (24-80 Km/h 15-50 MPH)

- Moan or high frequency feel in floor pan
- Worse at one particular engine speed
- Most evident at a particular throttle setting during acceleration
- May be felt or heard
- Engine, accessories or exhaust system are likely causes

DRIVELINE VIBRATION (80 Km/h 50 MPH+)

- No visible symptoms
- Rumble, buzz, boom or hum feel in floor pan
- Independent of engine speed
- Not affected by acceleration or deceleration
- Not reduced in neutral coast
- Can be duplicated on axle type hoist

DRIVELINE VIBRATION INCORRECT DRIVELINE ANGLE (40-72 Km/h 25-45 MPH)

- Vibration is strongest during acceleration and deceleration
- Changes in intensity with engine torque load
- Difficult to duplicate on a hoist because of decreased torque

ENGINE OR ACCESSORY VIBRATION (ALL SPEEDS)

- May occur at any vehicle speed
- Always occurs at the same engine speed
- Disappears during neutral coast
- Can be duplicated during engine run-up test
- Engine, clutch, torque converter or belt driven accessories are suspect

VEHICLE HARSHNESS (ALL SPEEDS)

- Loss of ride quality or steering response
- Increased interior noise level

WHEELS AND TIRES

When diagnosing NVH problems careful attention must be paid to the wheels and tires. As indicated before, there are several symptoms that can be caused by wheel or tire problems. Remember also that all tires generate some noise. This is especially true of all-season radial tires and snow tires which tend to "howl" on dry pavement. Some tires, nylon cord in particular, also tend to thump for a few miles after the vehicle has set for several hours.

Once you have determined that a wheel or tire problem is probable, perform a careful visual inspection. If the tire is badly worn or cupped (Figure 1) it should be replaced. If a diagonal cupping condition is evident on the rear tires of front wheel drive vehicles, check and adjust rear toe as described in the shop manual. Failure to correct this condition will result in premature tire wear. Spin the tire slowly and watch for signs of lateral or radial runout (Figure 2) that could indicate broken or shifted cord belts or a bent wheel. If no obvious runout is indicated, balance the tire and road test the vehicle a second time. If the second road test indicates continued vibration a runout test will be necessary.

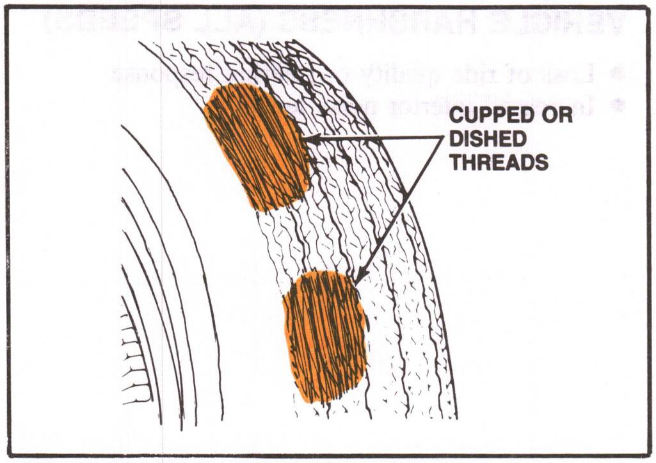


Figure 1 — Worn or Damaged Tires

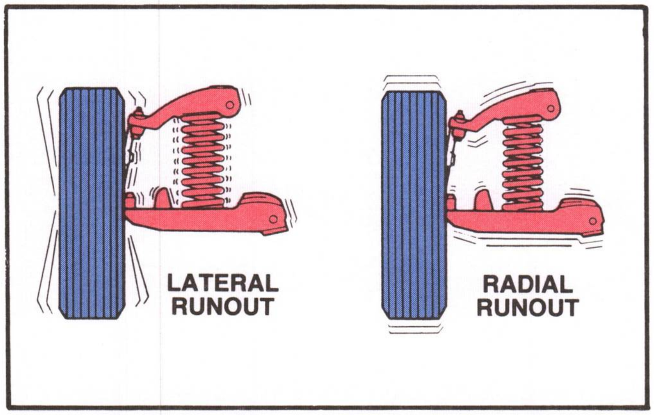


Figure 2 — Lateral and Radial Runout Conditions

Balance is important throughout the automobile, and it is of crucial importance in the wheel assembly.

Wheel balance falls into two general categories — static balance and dynamic balance.

STATIC BALANCE

Static balance simply means that the weight of the wheel and tire assembly is distributed equally around the axis of wheel rotation (the spindle). If this static balance condition exists, the wheel will have no tendency to rotate by itself, regardless of its position (Figure 3).

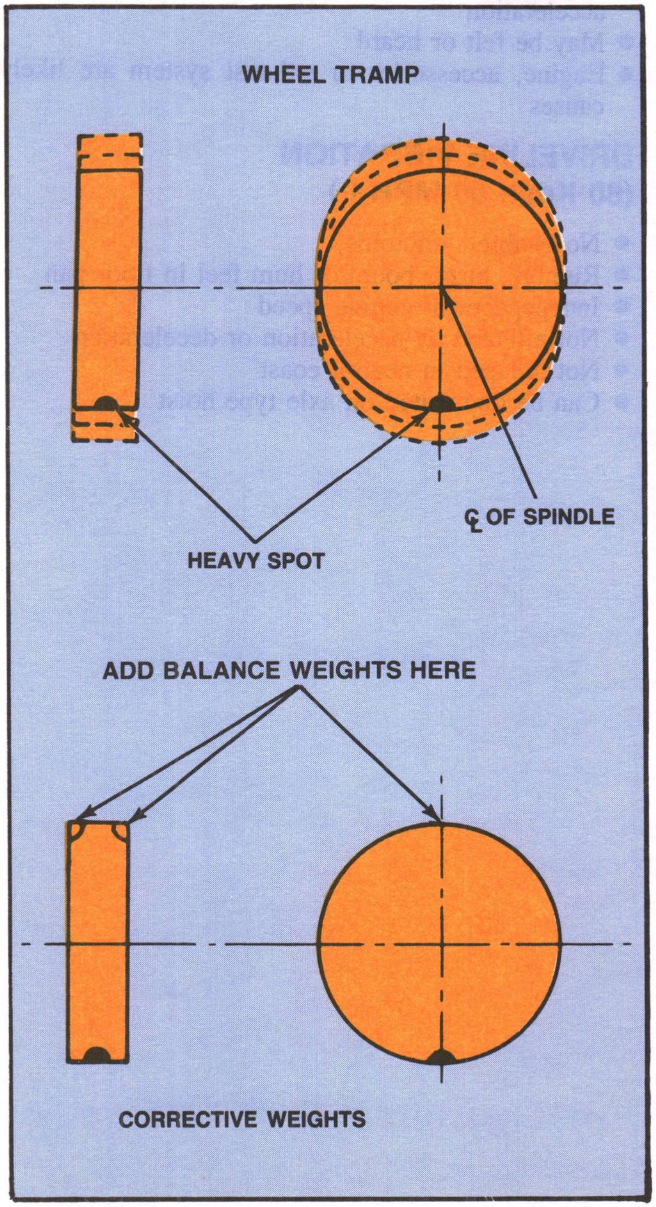


Figure 3 — Static Balance

If this static balance condition does not exist, the wheel will always rotate until its heaviest spot is at the bottom. When a wheel is out-of-balance statically, centrifugal force acting on the heavy spot will cause the wheel to "tramp" or "hop" as the vehicle is driven down the road. The speed at which the "tramp" or "hop" is dependent upon the degree to which the wheel is out-of-balance. In general, the greater the wheel imbalance, the lower the speed at which the "tramp" or "hop" becomes evident.

DYNAMIC BALANCE

Simply stated, dynamic balance means balance in motion. If a wheel and tire assembly is in dynamic balance, it must also be in static balance. However, it does not follow that a wheel and tire assembly which is in static balance is also in dynamic balance.

Earlier, we mentioned the conditions which must prevail to have static balance. The requirements for dynamic balance not only include the equal distribution of weight around the axis of rotation, but also equal weight distribution with regard to the centerline of the tire and wheel (Figure 4).

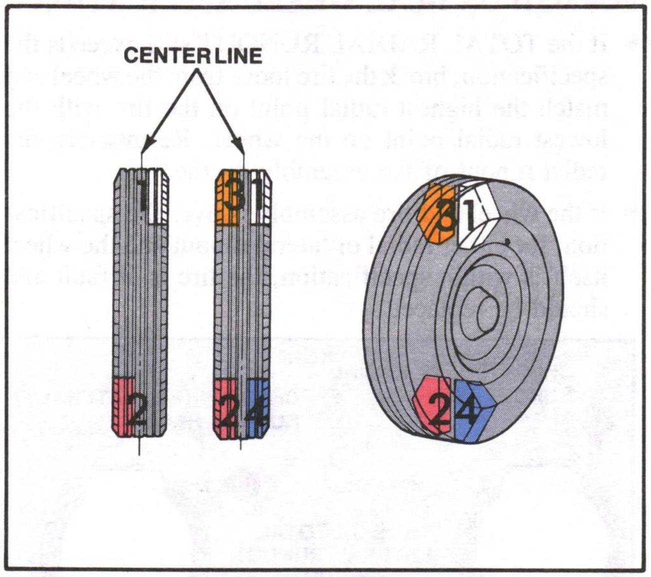


Figure 4 — Weight Distributed Equally Around the Tire Centerline

By installing the weights in this manner, dynamic balance is achieved and static balance is unaffected.

Wheel imbalance must not be confused with out-of-round tires or with excessive wheel runout caused by bent wheels or hubs.

EFFECTS OF TIRE INFLATION

Maintaining correct tire pressure is the most important element of good tire care. Tire pressure should be checked after the car has been parked at least three hours or before driving three miles. An 8-pound increase over "cold" pressure is not unusual following operations at high speeds or with a heavy load. Never, therefore, bleed air from a "hot" tire because the pressure is above normal.

- Under-inflation or overload decreases the rolling diameter and increases the contact area or "patch" area. Under these conditions, the tire sidewalls are allowed to flex excessively (Figure 5). Under inflated tires can also cause excessive tread noise and growl.

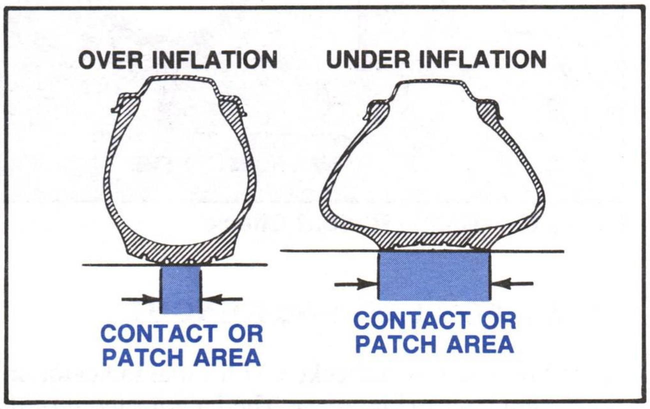


Figure 5 — Effects of Tire Inflation

- Conversely, too much tire pressure or over-inflation stiffens the tire, decreases the patch area, and increases the rolling diameter (Figure 5). Too much tire pressure can also cause harsh ride, bounce, and vehicle shake when traveling over bumps.

CHECK FOR RADIAL RUNOUT

Figure 6 shows how radial runout is checked with a dial indicator or tire runout gauge. The total tire and wheel runout is checked by placing the roller of the gauge on the center tread of the tire with the roller stem pointing toward the center of the wheel.

- If the radial runout on the center tread of the tire exceeds the specifications in the Shop Manual, check the radial runout of the wheel.
- The allowable total radial runout is .070 inch depending on vehicle application. Allowable wheel radial runout is .035 to .045 inch.

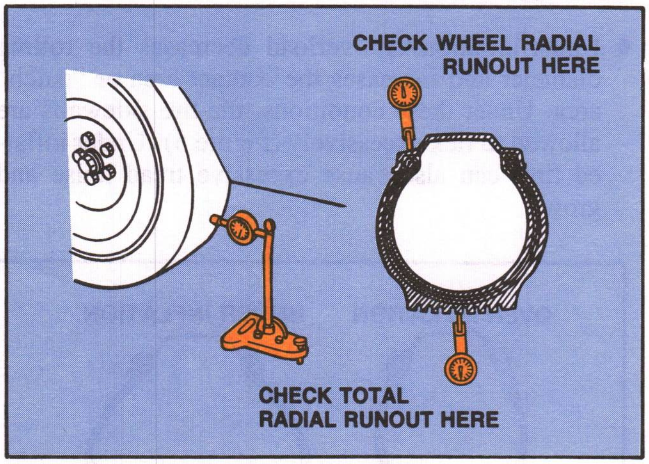

CHECK WHEEL RADIAL RUNOUT HERE
CHECK TOTAL RADIAL RUNOUT HERE

Figure 6 — Radial Runout Check

CHECK FOR LATERAL RUNOUT

Lateral runout is also checked with a dial indicator or a tire runout gauge (Figure 7). The lateral runout of the tire is checked at the tire scrub rib.

- If lateral runout of the tire exceeds specification, it is necessary to check the lateral runout of the wheel.
- The allowable total lateral runout is .070 inch depending on vehicle applications. Allowable wheel lateral runout is .045 inch on all current production vehicles.
- Always consult the appropriate shop manual for the exact specification for the vehicle being serviced.

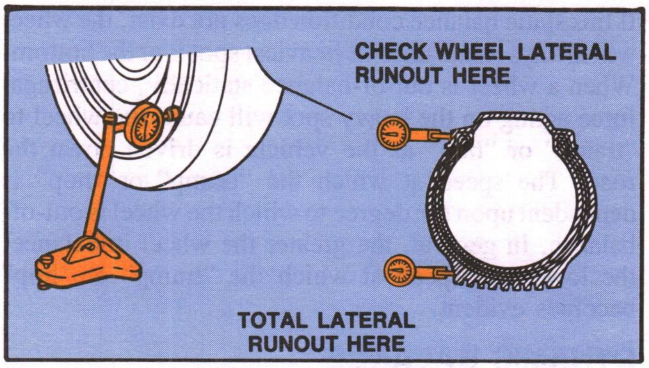


Figure 7 — Lateral Runout Check

CORRECTION OF EXCESSIVE RADIAL AND LATERAL RUNOUT OF TIRE AND WHEEL

If radial and lateral runout of both the tire and wheel are over specification, a good procedure is to remove the wheel and rotate it two studs on the drum. Then, re-measure the radial and lateral runout of the wheel and tire (Figure 8).

NOTE: THIS PROCEDURE CANNOT BE PERFORMED ON DUAL WHEEL APPLICATIONS.

- If the TOTAL RADIAL RUNOUT still exceeds the specification, break the tire loose from the wheel and match the highest radial point on the tire with the lowest radial point on the wheel. Re-measure the radial runout of the assembly on the car.
- If the wheel and tire assembly is over the specification, for either radial or lateral runout and the wheel itself is within specification, the tire is at fault and should be replaced.

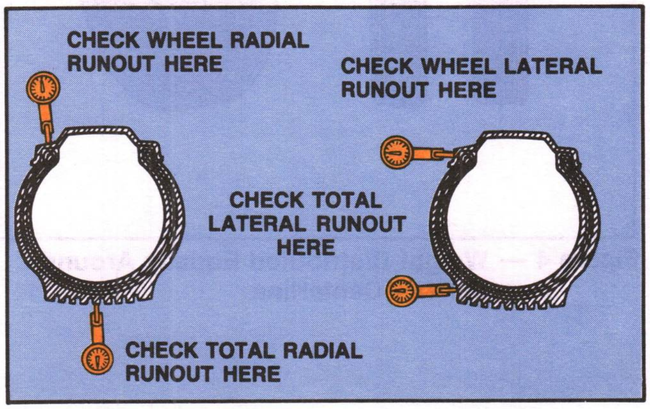

CHECK WHEEL RADIAL RUNOUT HERE
CHECK WHEEL LATERAL RUNOUT HERE
CHECK TOTAL LATERAL RUNOUT HERE
CHECK TOTAL RADIAL RUNOUT HERE

Figure 8 — Radial and Lateral Runout Checks

WHEEL BEARINGS

WHEEL BEARING ROUGHNESS

Wheel bearing noise occurs when the bearing race thrust surface becomes grooved or rough due to the surface wearing or flaking off (Figure 9). The bearings fall into these grooves (called Brinell marks) and emit a hammer noise which varies between a grinding condition on some units to a thumping condition on other units. The noise is generally loudest at a slow to medium road speed (15 to 35 MPH) and can usually be isolated to front or rear wheel bearings at the time of the road test.

ISOLATING BEARING NOISE

When performing the road test, use the techniques listed below to help isolate a possible wheel bearing malfunction.

Front Wheel Bearings

1. While driving at 15 to 20 MPH swerve vehicle from side to side in sweeping turns.
2. If noise increased when swerved to the right disassemble and inspect the left bearing. Check right bearing if noise was loudest when swerved left.
3. If noise did not change see rear wheel bearings.
4. On front wheel drive vehicles verify CV-joint condition before replacing bearings.

NOTE: DO NOT REPLACE A TAPERED ROLLER BEARING UNLESS VISIBLE DETERIORATION IS PRESENT.

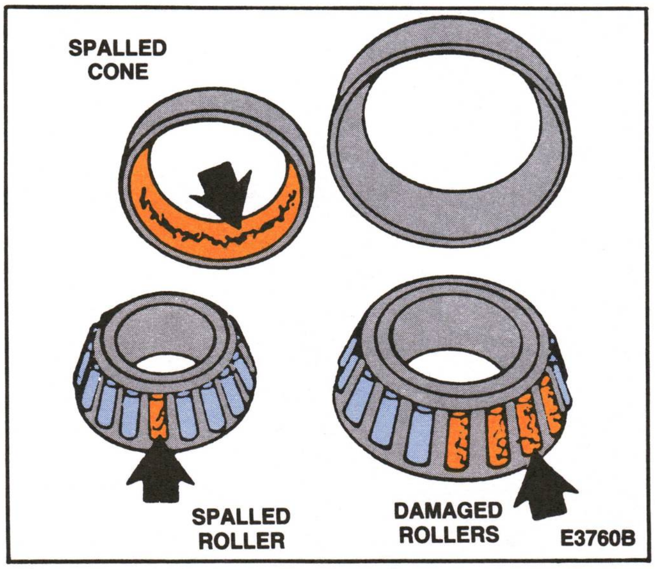


Figure 9 — Typical Bearing Malfunction

Rear Wheel Bearings

1. While driving at 15 to 20 MPH lightly apply the service brakes. If the noise does not decrease, consult the drive axle section of this book.
2. For integral axle applications remove the axle shaft and examine the shaft bearing thrust surface for scoring or pitting. If present, replace the axle shaft and bearing.
3. For vehicles using a sealed ball bearing, remove the axle shaft and turn the bearing by hand. If the bearing feels rough or overly tight, replace it.

Wheel Bearing Adjustment

Use the following procedure to adjust the front wheel bearing of rear wheel drive vehicles or the rear wheel bearings of front wheel drive vehicles. Consult the Light Truck shop manual for 4x4 wheel bearing adjustment.

1. Remove the brake caliper on rear drive vehicles and wire it out of the way.
2. Remove the grease cap, cotter pin and nut lock, and back off the adjusting nut three turns.
3. Rock the drum or rotor in and out to unseat the bearing cones.
4. Rotate the hub and torque the adjusting nut to 23-34 N•m (17-25 ft.-lb.).
5. Back off adjusting nut one-half turn and re-torque to 1.1-1.7 N•m (10-12 ft.-lb.).
6. Re-install nut lock, a new cotter pin and grease cap.
7. Check hub for free rotation. Re-install brake caliper and pump the brake pedal several times to normalize the calipers.

WHEEL BEARING ADJUSTMENT — DANA FULL FLOATING REAR AXLE

1. With the hub and rotor assembly installed, install the outer wheel bearing cone and roller and start the bearing hub nut making sure the hub tab is properly located in the keyway prior to thread engagement.
2. Install the F-Super Duty Hub Wrench Tool T88T-4252-A so that the drive tangs of the tool engage the four slots of the nut. Apply inward pressure to the socket to separate the ratcheting components of the nut, tighten to 88-102 N•m (65-75 ft.-lb.). Back off 90 degrees, then re-tighten to 20-27 N•m (15-20 ft.-lb.). Rotate hub occasionally while tightening to set the bearings.

WHEEL BEARINGS

WHEEL BEARING ADJUSTMENT — FORD FULL FLOATING REAR AXLE

1. With the hub and rotor assembly installed, install Hub Wrench Tool T85T-4252-AH on spindle.
2. Install torque wrench and tighten hub nut to 75-88 N•m (55-65 ft.-lb.). Rotate hub occasionally while tightening. NOTE: The hub nut will ratchet as torque is applied.
3. After tightening to specification 75-88 N•m (55-65 ft.-lb.), ratchet back five (5) teeth or notches on the hub nut. **Five (5) "clicks" must be heard** during this operation in order to have performed it correctly.

FRONT DISC BRAKE ROTOR OR REAR AXLE SHAFT FLANGE RUNOUT

Before a wheel is condemned because of lateral or radial runout, the brake rotor or axle shaft must be inspected since excessive hub runout will be a factor in the wheel and tire runout readings. This check will require reading the rotor or axle flange hub runout, drum or rotor pilot runout and wheel bolt runout.

Remove the wheel and brake drum (if a rear axle flange is being measured) and make sure the wheel bearing adjustment (if applicable) is correct before taking a reading. Place the dial indicator stem against the flange face (Figure 10). Turn the rotor or axle shaft one full revolution and read the total indicator movement. If the reading is above the acceptable limit the rotor or axle shaft must be replaced. On front wheel drive or rear disc brake vehicles the rotor to hub mounting surface should be carefully checked for interference before condemning the rotor.

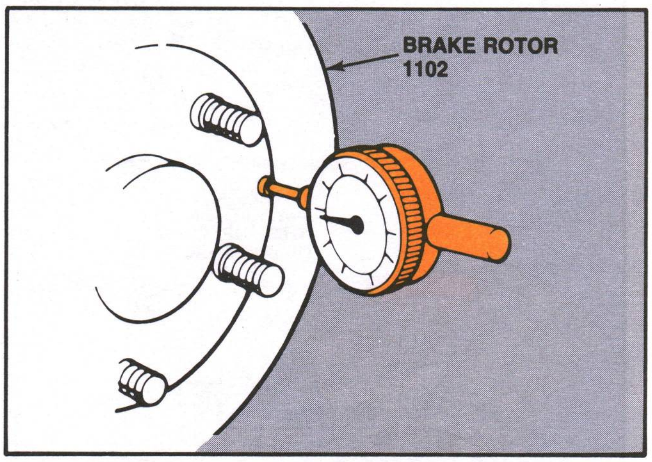


Figure 10 — Flange Face Lateral Runout

Hub or drum pilot runout should be measured as indicated in Figure 11.

Wheel bolt runout must be carefully checked by placing the dial indicator stem against the wheel bolt as close to the rotor face as possible. Zero the indicator and carefully pull the indicator stem back. Rotate the hub to the next wheel bolt and release the stem. Read the dial indicator and continue until all wheel studs have been read. If the total runout exceeds specification replace the hub.

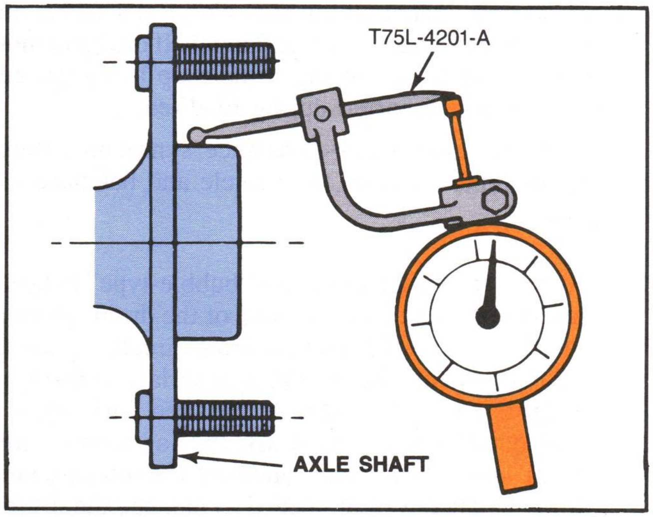


Figure 11 — Drum Pilot Radial Runout

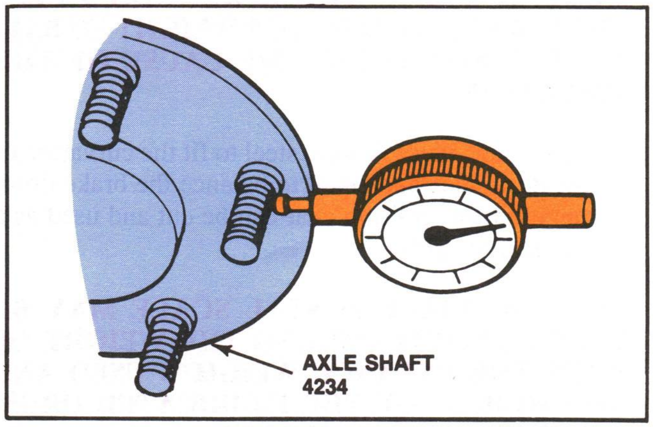


Figure 12 — Wheel Bolt Runout

BRAKE DRUM BALANCE

Rear brake drum imbalance can cause a vibration condition on light trucks that sometimes cannot be compensated for by wheel balancing.

If rear brake drum imbalance is suspected, raise the rear end of the vehicle taking proper precautions. Remove the rear wheel and tire assembly.

Before testing, install all lug nuts with flat washers on them to retain the drums to axle flanges. If drums do not have brake weights, run the vehicle up to the speed where vibration occurred during road test.

If the drums exhibit out-of-balance symptoms, they should be removed from the vehicle and balanced as follows:

1. Position the brake drum on a "bubble-type" balancer and noting the "heavy" side of the drum, place a wheel balance weight on the drum directly opposite the heavy point. Select the appropriate number of weights until the bubble balance indicates a "balanced" condition. Mark the location of the "light" side of the drum, and note the total amount of the balance weight needed to balance the drum.

NOTE: A DRUM WHICH REQUIRES LESS THAN 56.6 GRAM (2 OZ.) OF WEIGHT TO BALANCE IS NOT THE PRIME CAUSE OF THE VIBRATION.

2. Fabricate a piece of mild steel to fit the curvature of the drum face and equal to balance the brake drum (an old flywheel ring gear can be cut and used as a balance weight).

NOTE: A SMALL POSTAL SCALE MAY BE USED FOR DETERMINING THE WEIGHT OF BOTH THE BALANCE WEIGHTS USED AND THE WEIGHT OF THE FABRICATED DRUM BALANCE WEIGHT NEEDED.

3. Position the drum balance weight on the drum face in the location on the lightside of the drum indicated, as shown in Figure 13. Arc weld (tachweld 6.35 mm or 1/4 inch long) the balance weight to the drum face.

NOTE: UNDER NO CONDITION SHOULD ANY OTHER WELDING METHOD BE USED OTHER THAN ARC WELDING. TO PREVENT DRUM DISTORTION, DO NOT USE A CURRENT SETTING OF MORE THAN 100 AMPS.

4. Install the balanced drum on the vehicle.
5. Static balance both rear wheels and tires and install on vehicle.
6. Road test to verify correction.

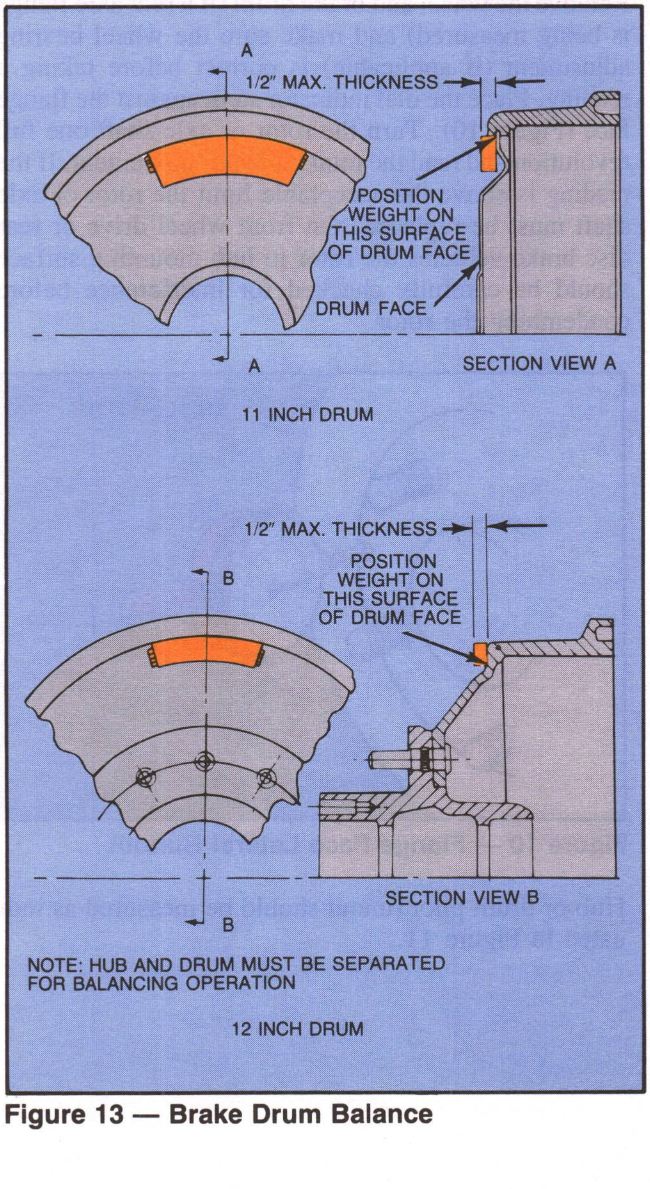

A
1/2" MAX. THICKNESS
POSITION WEIGHT ON THIS SURFACE OF DRUM FACE
DRUM FACE
A
SECTION VIEW A
11 INCH DRUM
1/2" MAX. THICKNESS
B
POSITION WEIGHT ON THIS SURFACE OF DRUM FACE
SECTION VIEW B
B
NOTE: HUB AND DRUM MUST BE SEPARATED FOR BALANCING OPERATION
12 INCH DRUM

Figure 13 — Brake Drum Balance

DRIVELINE

DRIVELINE VIBRATION

This is a higher-frequency, lower-amplitude vibration than high-speed shake, directly related to road speed, and usually more noticeable at higher road speeds, 72 km/h (45 mph) and up. It is felt in the floor pan or heard as a rumble, hum or boom. It will exist in all drive modes, but may vary somewhat in acceleration, deceleration, float or coast modes. If the vibration is particularly responsive to heavy acceleration or deceleration, especially at lower speeds, driveline angles should be checked (see page 18). A driveline vibration can usually be duplicated with the axle supported on a hoist or jack stands; although light brake application while accelerating and decelerating, to simulate road load resistance, may be necessary to bring it out.

1. Raise vehicle promptly after road-testing, on twin-post hoist or jack stands, to prevent tire flat-spotting. Engage drive train and run-up to observed road test speed to verify presence of vibration. If not evident, check non-driving wheels with wheel-balancer spinner to rule out imbalance as a possible cause. On 4x4's, unlock front hubs or remove hub covers before spinning wheels. If required, balance non-driving wheels and repeat road test. If vibration is still evident, proceed to driveshaft inspection, Step 3.

2. If vibration appeared in road-speed hoist-test, mark relative position of drive wheels on axle or hub lugs to permit reinstallation in original position, and remove wheels. Secure brake drums, if present, by installing all lug nuts in reversed position, and repeat road-speed run-up. If vibration is gone, see drive wheel runout and balance procedures page 20. If vibration persists, proceed to Step 3.

3. Inspect driveshaft for signs of physical damage, undercoating, or improperly seated universal joints. Rotate the driveshaft slowly by hand and feel for binding or end play in the U-joint trunnions or the centering device in a double cardan type. Check the index marks (paint spots) on rear of shaft and pinion yoke or companion flange. If these marks are more than 90 degrees apart, disconnect shaft and re-index to align marks as close as possible. Clean shaft and repair or replace universal joints as necessary, or replace shaft if damaged. After any corrections are made, re-check vibration at road test speed. If gone, re-install wheels and road test. If vibration persists, or driveshaft passes inspection, proceed to runout check, Step 4.

4. With vehicle on hoist and wheels off, measure runout at front, center, and rear of driveshaft with indicator (Figure 14). Rotate shaft by turning a brake drum or rotor. For truck two-piece driveshafts, see page 36 for special runout checking procedures. On a one-piece shaft, if runout exceeds .89 mm (.035″) at front or center, the driveshaft must be replaced. If front and center are within this limit, but rear runout is not, mark the rear runout high point and proceed to Step 5. If runout is within limits at all points, proceed to driveshaft balancing. See Step 1 under BALANCE on page 16.

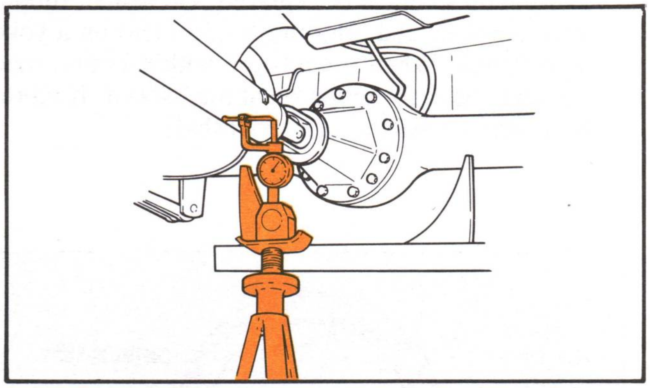


Figure 14 — Measuring Driveshaft Runout

5. Note or mark the indexing of driveshaft to rear axle pinion flange (Figure 15). Disconnect the shaft, re-index 180 degrees, and re-connect. Re-check runout at shaft rear, and if still over .89 mm (.035″), mark high point and see Step 6. If runout is no longer excessive, check for vibration at road test speed, and, if still present, proceed to Step 1 under BALANCE on page 16.

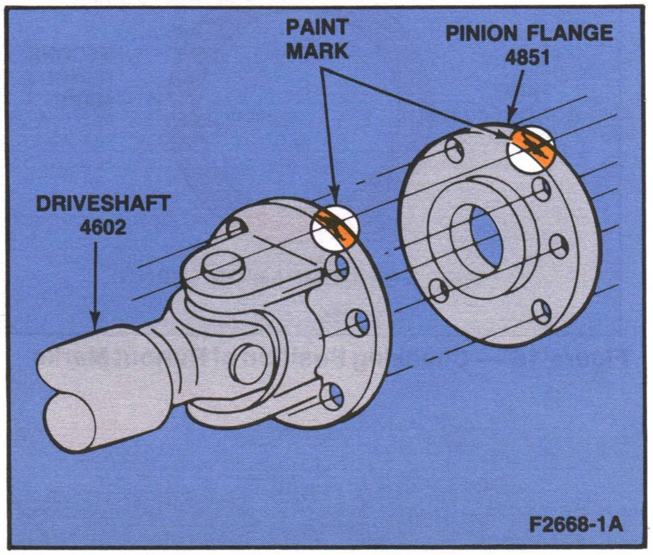


Figure 15 — Indexing Rear Axle Flange

6. Excessive driveshaft runout may originate in the shaft itself, the pinion yoke or the flange. To find the source, compare the two high points determined in Steps 4 and 5 (see Figure 16). If the marks are close together, within about 25 mm (1 inch), the shaft is eccentric and should be replaced. Re-check the shaft for vibration after replacement. If the marks are on opposite sides of the shaft, about 180 degrees apart, the yoke or flange is responsible. A circular flange may be checked before connecting the driveshaft. If the flange runout exceeds 0.13 mm (.005 inch), a bent pinion is indicated and the ring-and-pinion set must be replaced. Driveshaft runout should not exceed .089 mm (.035 inch) on a yoke type flange. When runouts are within limits, road test and check for vibration at road speed. If vibration persists, balance the driveshaft.

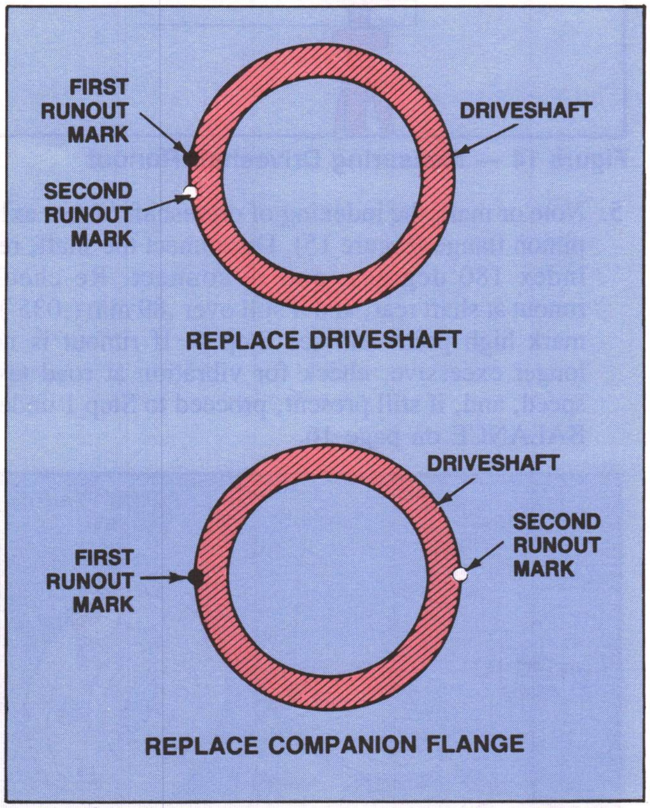


Figure 16 — Checking Position of Runout Marks

BALANCE

The information below outlines procedures for balancing.

1. Driveshaft balancing involves installing one or two Whittek-type hose clamps on the driveshaft, near the rear end of a one-piece shaft, or at the front of the rear shaft in a two-piece system. Best positioning of the hose clamp head(s) can be determined by trial-and-error, if special balancing equipment is available, see page 17 for balancing procedure. The hose-clamp technique is applicable only to full-size cars and light trucks, because of reduced driveshaft-to-tunnel clearance in smaller models, in which imbalance conditions may be improved by driveshaft re-indexing (see Step 6).
2. If the driveshaft was not previously re-indexed to correct runout, mark original position of shaft relative to pinion flange, re-index 180 degrees, and recheck vibration. If substantially improved, a road test may show that the problem is solved, but if worse, return the shaft to the original position.
3. Mark off the rear of the driveshaft into four approximately equal sectors, and number the marks 1 through 4 (see Figure 17). Install a hose clamp on the shaft with its head at position No. 1. Check for vibration at road speed. Recheck with the clamp at each of the other positions, to find the position for minimum vibration. If two adjacent positions show equal improvement, position the clamp head between them.

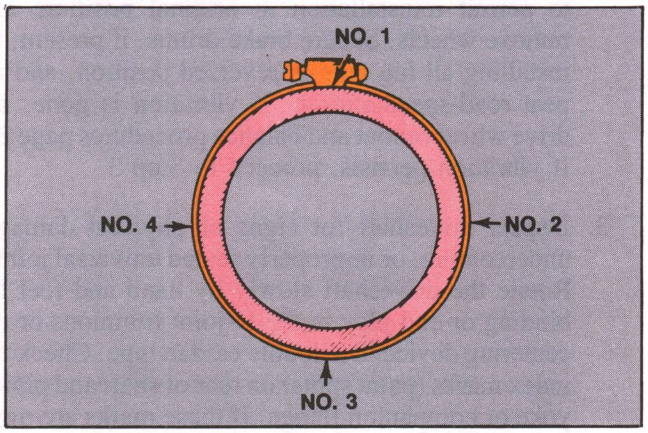


Figure 17 — Installing Whittek Clamps

4. If vibration is still not acceptable, add a second clamp at the same position and re-check vibration (Figure 18). If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in Step 3 (see Figure 19). Initially, separate the clamp heads about 12 mm or 1/2 inch, and re-check vibration at road speed. Repeat the process with increasing separation until the best combination is found, or vibration is reduced to an acceptable level.

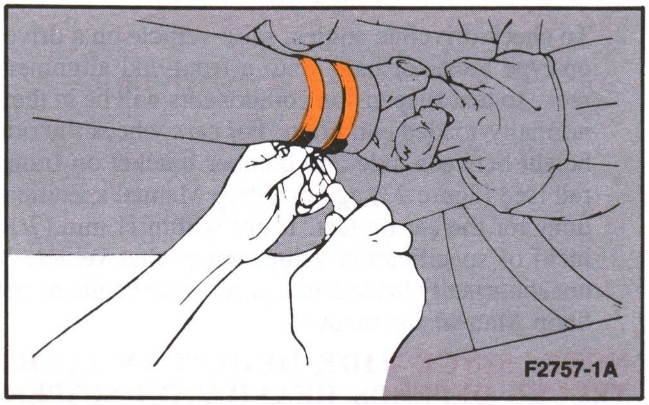


Figure 18 — Balancing Driveshaft

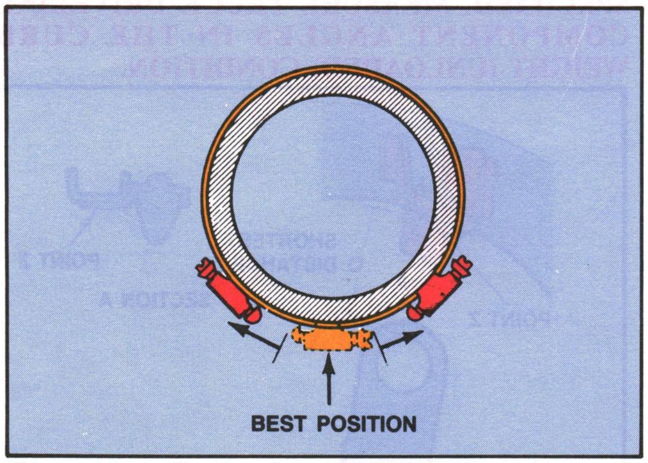


Figure 19 — Finding Best Position for Clamp Location

5. Re-install wheels and road test, since vibration noticeable on the hoist may not be a problem on the road. If vibration is still not acceptable, check TSB articles for availability of an appropriate axle pinion nose damper. If available, install damper and road test. If not available, or if road test not acceptable, replace axle ring gear and pinion set.
6. For late-model unitized body vehicles to which the hose-clamp technique is not applicable, the driveshaft can be re-indexed at the pinion flange to any of eight positions to minimize imbalance.
7. Before disconnecting the driveshaft, mark one of the shaft mounting bolt holes "A" (Figure 20), and number the pinion flange holes "1" through "8", starting with the one mating with "A". The original position can then be identified as "A-1". Re-index the shaft 180 degrees, to "A-5", (Figure 21) and road test. If not satisfactory, repeat for positions "A-3" and "A-7", and if necessary, between the best two of the previous four tested, until the vibration stops or the best position is found. If vibration is still not acceptable, install a pinion nose damper on the rear axle, if available.

NOTE: DRIVESHAFT-TO-AXLE-FLANGE BOLTS REMOVED FOR INDEXING TRIALS MAY BE RE-USED, AND SHOULD BE TORQUED TO (95-129 N•M) 70-95 FT.-LB. IF SERVICE BOLTS ARE NEEDED, USE PART NO. N800232-S2 BOLT AND N630175-S2 LOCKWASHER.

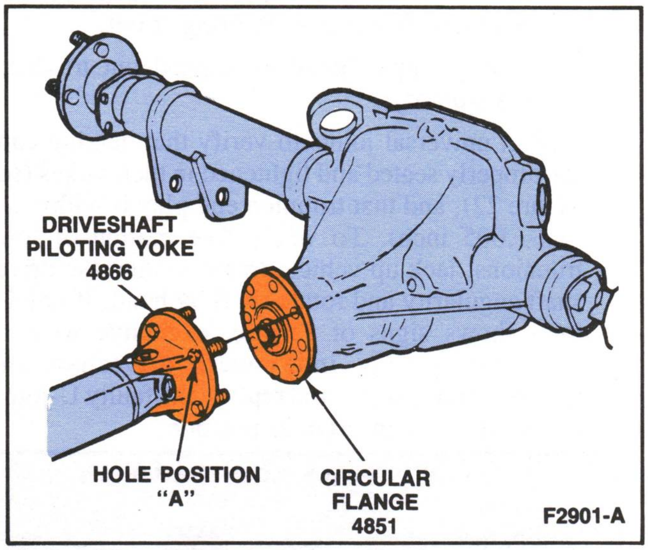


Figure 20 — Driveshaft Indexing

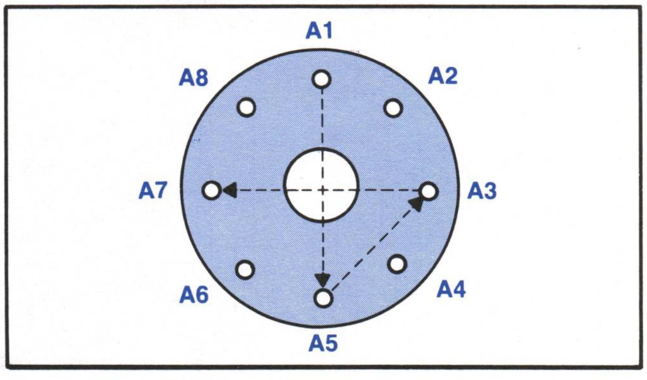


Figure 21 — Flange Indexing Procedure

ACCELERATION/DECELERATION SHUDDER (DRIVELINE ANGLE)

A shuddering feel or audible rumble at speeds up to 72 km/h (45 mph), most pronounced under heavy acceleration or deceleration and reduced or eliminated in float or neutral-coast modes, usually indicates incorrect driveline angles, between driveshaft and rear axle pinion, and possibly between front (coupling) and rear shafts in two-piece drivelines (see page 21). Other possible causes are excessive U-joint trunnion end play, off-center mounting of U-joints or binding U-joints.

Driveline angularity is controlled by ride (spring) height, suspension control arm geometry or axle-to-spring shims in leaf spring applications, and center bearing alignment in two-piece shafts (truck). Whether incorrect angle effects are more pronounced under acceleration, or deceleration, depends on whether ride height or pinion angle deviations from specification are plus or minus. The condition usually cannot be duplicated on the hoist because considerable road load torque resistance is required to bring it out.

The following steps should be carried out to check driveline angularity:

1. Inspect universal joints to verify that bearing caps are properly seated and tightened in their yokes (see Figure 22), and that trunnion end play is within .13 mm (.005 inch). To verify free motion of joint trunnions, jack up vehicle frame to increase driveshaft angularity and rotate shaft by hand. If any U-joint shows signs of seizure, excessive wear or improper seating, index-mark driveshaft and flange, remove shaft, and replace the faulty U-joint. Re-install shaft in original position.

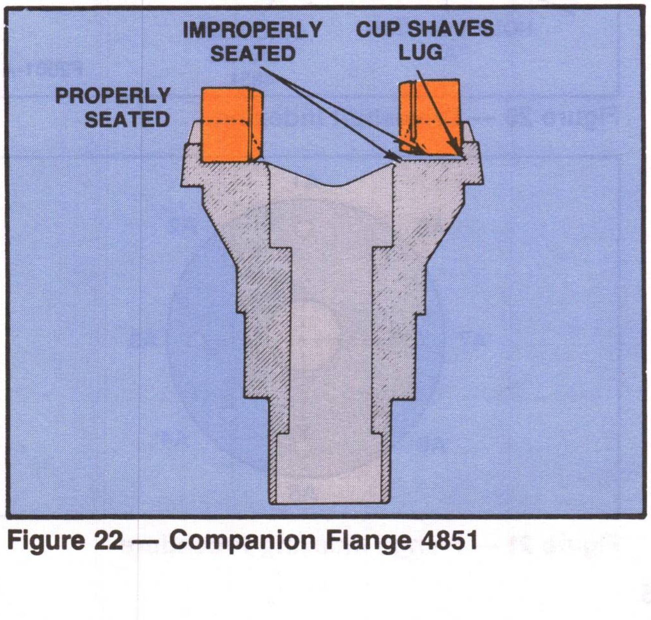


Figure 22 — Companion Flange 4851

NOTE: DRIVELINE ANGLE SPECIFICATIONS ARE DIFFERENT FOR CAR AND LIGHT TRUCK, AND MEASUREMENT TECHNIQUES ARE NOT INTERCHANGEABLE. THE ANGLE SPECIFIED FOR PASSENGER CARS IS THE ANGLE BETWEEN DRIVESHAFT AND REAR AXLE PINION, MEASURED WITH THE VEHICLE AT SPECIFIED RIDE HEIGHT. TRUCK ANGLES ARE SPECIFIED FOR INDIVIDUAL DRIVELINE COMPONENTS, MEASURED RELATIVE TO THE VEHICLE FRAME.

2. To check driveline angles, raise vehicle on a drive-on type hoist, or back onto a front-end alignment rack, so that suspension components will be in their normally-loaded condition. For cars, check the ride height between axle and bumper bracket on frame rail (see Figure 23) against Shop Manual specifications for the car on test. If not within 11 mm (7/16 inch) of specification value, verify that vehicle is not abnormally loaded and correct ride height as per Shop Manual instructions.

NOTE: SINCE RIDE HEIGHT IN LIGHT TRUCKS DEPENDS HEAVILY ON SUSPENSION EQUIPMENT AND LOADING, IT IS NOT SPECIFIED. MEASURE TRUCK DRIVELINE COMPONENT ANGLES IN THE CURB WEIGHT (UNLOADED) CONDITION.

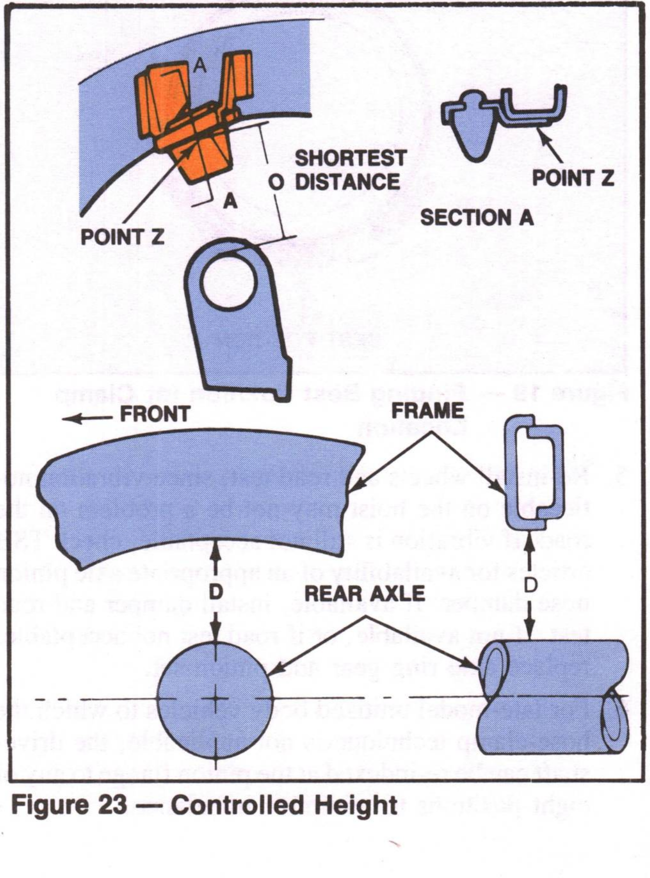


Figure 23 — Controlled Height

3. Car Pinion Angle

   When ride height is within limits, rotate driveshaft until pinion flange yoke is vertical, and check the driveshaft-to-pinion angle with gauge kit T68P-4062-A (see Figure 24) or equivalent. To use the gauge kit working from the left side of the vehicle, seat the vee magnet securely on the bottom of the driveshaft and attach the gauge. With the adjusting screw, zero the left edge of the bubble. Then seat the gauge on the pinion flange U-joint bearing cap and read the angle (between driveshaft and pinion) at the edge of the bubble. Compare with appropriate specification and correct pinion angle as required, in accordance with Shop Manual instructions. Check the engine/transmission angle at the driveshaft front U-joint. If not within 1 degree of the pinion angle, check for proper applications and installation of engine/transmission mounts.

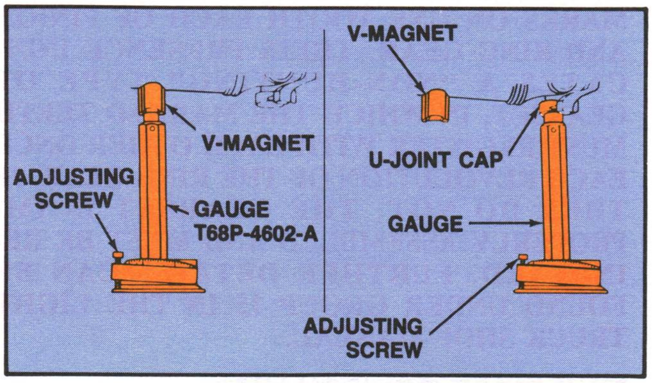


Figure 24 — Positioning Pinion Angle Gauge

4. Light Truck Driveline/Pinion Angles

   Truck angles are measured from the straight portion of the frame rail, forward of the rear spring bracket, to the component in question. Angles up to about 12 degrees can be measured with the gauge kit as follows: Place the gauge, with vee magnet if necessary, on the component to be measured and zero the bubble; transfer the gauge and vee magnet to the bottom of the frame rail, and read the total angle of the component.

To measure angles in excess of 12 degrees or if pinion angle gauge kit is not available, an adjustable bubble protractor (spirit level) may be substituted. Like the gauge kit the procedure for cars and light trucks differ. Follow the procedure as listed below:

Cars:

a. Raise the vehicle on an axle-type hoist.
b. Rotate the driveshaft until the companion flange U-joint is at true vertical.
c. Place the protractor on the U-joint flange boss and zero the bubble.
d. Transfer the protractor to the driveshaft tube and read the angle.
e. Consult the appropriate shop manual for corrective techniques.

Light Trucks:

a. Raise the vehicle on an axle-type hoist.
b. Place the protractor on the straight section of the frame forward of the rear spring forward anchors and level the bubble.
c. Transfer the protractor to the driveshaft tube and record the reading (measure and record both the coupling shaft and rear driveshaft angles on two-piece applications).
d. Span the protractor across two adjacent bolt heads on the oil pan rail and record the engine angle.
e. To measure pinion angle on an integral axle, span the protractor across two adjacent bolt heads vertically on the axle cover and read the angle in relation to the 90-degree mark. Example: if the protractor reads 85 degrees, pinion angle is five degrees. For removable carrier axles, span the protractor across two bolt heads vertically on the drive pinion retainer and read the angle relative to the 90-degree mark.
f. To correct driveline angles, follow the shop manual procedure for the type of driveline being serviced.

DRIVELINE

The driveline configurations and angles illustrated in Figure 25 are typical, but for actual angle specifications, refer to the appropriate shop manual. In two-piece driveshaft installations, coupling (front) shaft angle can be corrected by shimming the center bearing support.

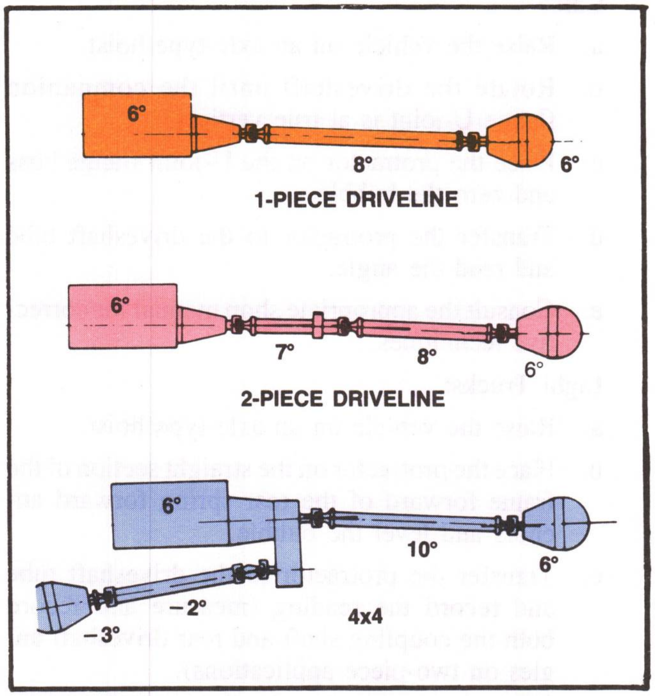


Figure 25 — Typical Drivelines and Angles

5. If driveline angle correction, and driveline runout/balance procedures do not eliminate the vibration condition, the axle ring and pinion gearset should be checked for backlash variation, which is indicative of runout conditions that won't show up in other tests. Measure ring gear backlash as shown in Figure 26, on thirty consecutive ring gear teeth, and note the variation between high and low readings. If over .10 mm (.004 inch), replace the gearset after checking differential case runout, ring gear runout and pinion flange runout.

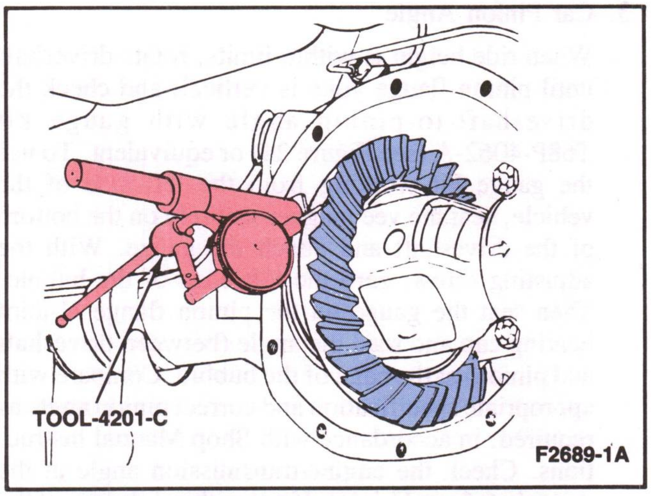


Figure 26 — Checking Ring and Pinion Gear Backlash

NOTE: CHECK FOR PRESENCE OF INDEX MARKS ON ONE TOOTH EACH OF PINION AND RING GEAR. THEIR PRESENCE INDICATES A "NON-HUNTING" TYPE OF GEARSET, IN WHICH THE MARKED TEETH MUST REGISTER WITH EACH OTHER ONCE EACH REVOLUTION OF THE RING GEAR. IF THEY DO NOT, THE GEARSET IS IMPROPERLY ASSEMBLED AND MUST BE REINDEXED. FURTHER DETAILS CAN BE FOUND UNDER GROUP 15 IN THE LIGHT TRUCK SHOP MANUAL.

TWO-PIECE DRIVESHAFTS

The two-piece driveshaft used in longer wheelbase light truck models (Figure 27), introduces some special considerations to NVH diagnosis and analysis. As compared with a one-piece installation, the two-piece design includes a front, or "coupling" shaft, a rubber-insulated frame-mounted center bearing, a splined slip joint and an intermediate universal joint at the front of the rear driveshaft.

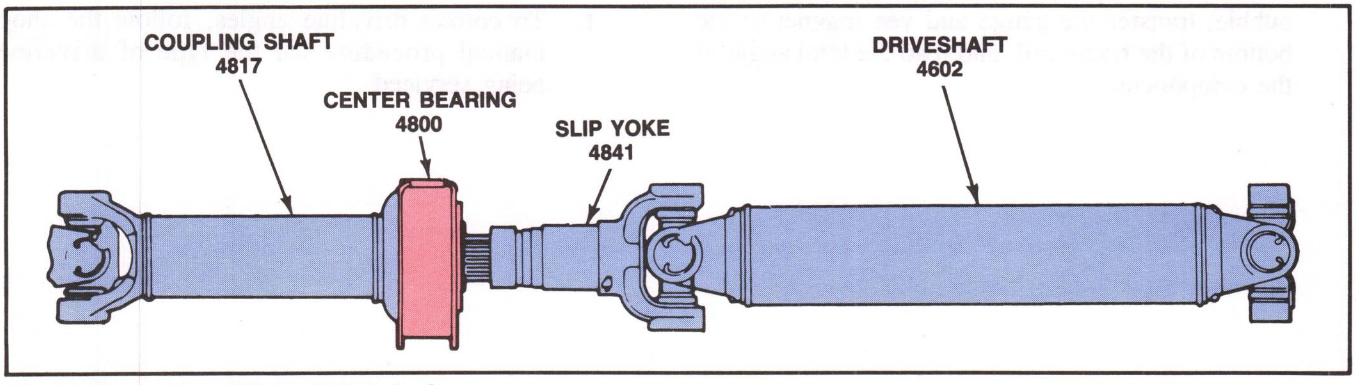


Figure 27 — Two-Piece Driveshaft

DRIVELINE ANGLES

Different driveline angles are specified for the coupling and rear shafts (Figure 28), and angularity adjustments may require spacers between the center bearing support and frame crossmember to control bearing position.

INSULATOR COMPRESSION

Compression of the rubber center bearing insulator (Figure 29) is critical to vibration control. If not sufficiently compressed, because of an undersize insulator or oversized support bracket, or due to deterioration of the rubber, the insulator may permit driveshaft runout under load, and variation of driveline angles. An oversized insulator may be installed to increase compression.

If over-compressed, the center bearing insulator may approach a bound-up mount condition, transmitting normal driveshaft vibration into the vehicle frame.

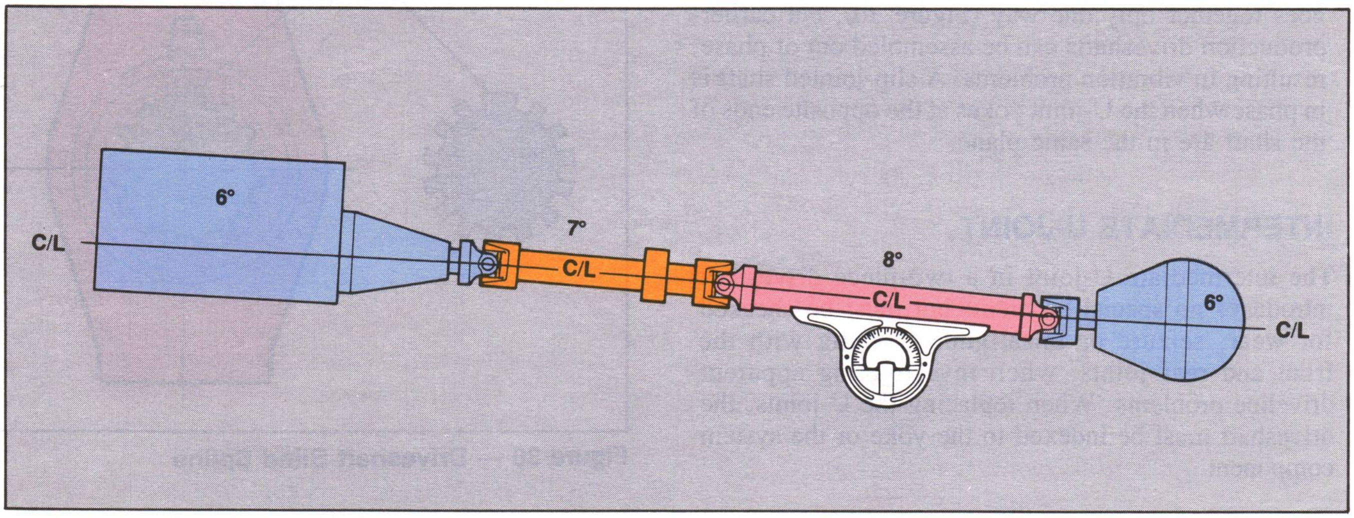


Figure 28 — Driveline Angle Measurement

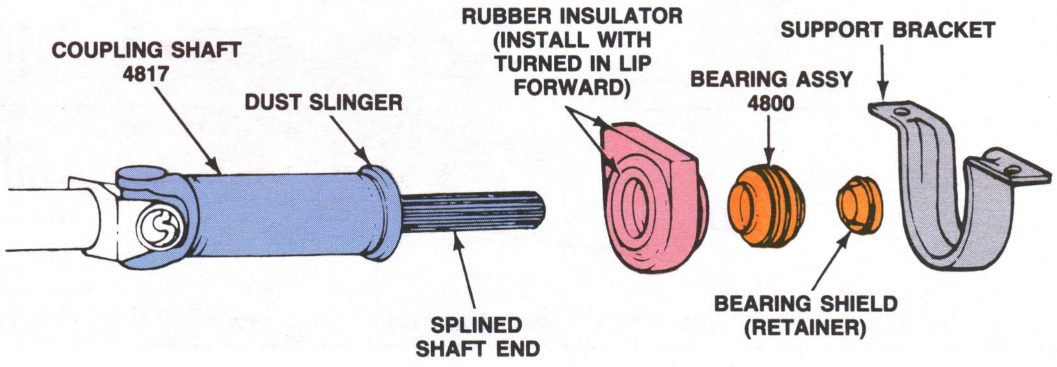


Figure 29 — Center Bearing Assembly Disassembled

no drive shaft over 70"

DRIVELINE

SLIP-JOINT

The driveshaft slip joint splines are Teflon-coated to prevent siezing or binding under load, but if contaminated with dirt or hardened grease, or galled because of insufficient lubrication, it may fail to slide freely under maximum-torque loads. This can result in a "grunt" at breakaway from standstill or at the end of a hard brake application. Cleaning and lubricating the splines will usually free them up.

In current production, a blind-spline joint is used that goes together only one way (Figure 30), but earlier-production driveshafts can be assembled out of phase, resulting in vibration problems. A slip-jointed shaft is in phase when the U-joint yokes at the opposite ends of the shaft are in the same plane.

INTERMEDIATE U-JOINT

The intermediate U-joint in a two-piece driveshaft introduces no special problems but must be checked for wear, seizure or misalignment along with the front and rear joints, when investigating apparent driveline problems. When replacing the U-joints, the driveshaft must be indexed to the yoke or the system component.

DRIVESHAFT BALANCING

Finally, for the hose-clamp balancing procedure, a two-piece driveshaft is more sensitive to imbalance at the front of the rear shaft, and the clamp(s) should be placed at that position. Otherwise, the procedure is the same as for one-piece driveshafts (Figures 31 and 32).

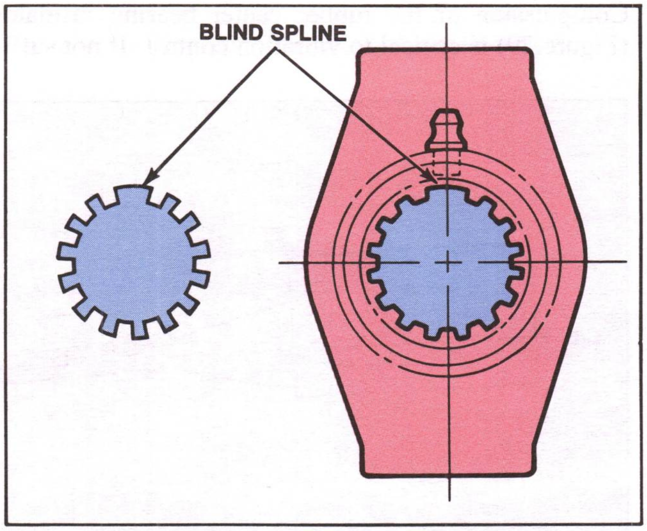


Figure 30 — Driveshaft Blind Spline

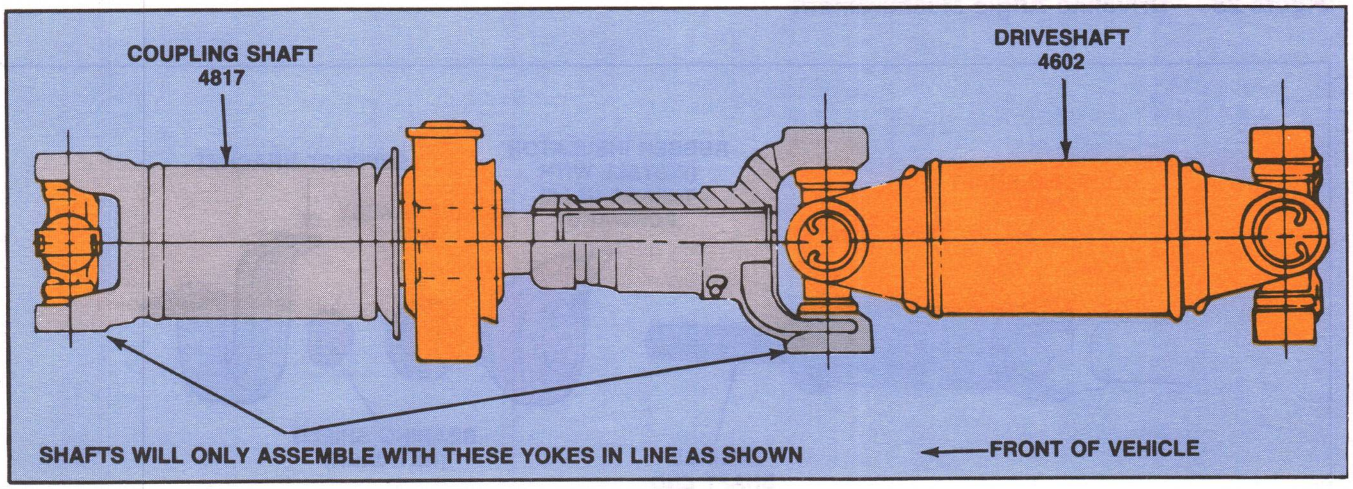


Figure 31 — Two-Piece Driveshaft Phasing (Typical)

RUNOUT CHECKS

Runout checks should be made at six points, as shown in Figure 32, and the same .89 mm (.035 inch) limit applies as for one-piece shafts. If runout is excessive at points A through E, the coupling shaft or driveshaft must be replaced, but if at point F, re-indexing to the pinion flange should be tried first.

DOUBLE CARDAN U-JOINTS

Double cardan U-joints are used in some car and light truck applications. When servicing an NVH condition, examine the U-joints and rock the center yoke up and down to check for play in the center yoke socket (Figure 33). If any movement is noted, the assembly should be repaired prior to any other driveline service. The procedures for driveshaft balance are identical to a single cardan type.

The double cardan assemblies used in light trucks are fitted with a flush type lube fitting for the centering stud. This fitting must be lubricated according to the maintenance schedule to prevent premature wear. Car applications have a Zerk fitting in each U-joint for periodic lubrication.

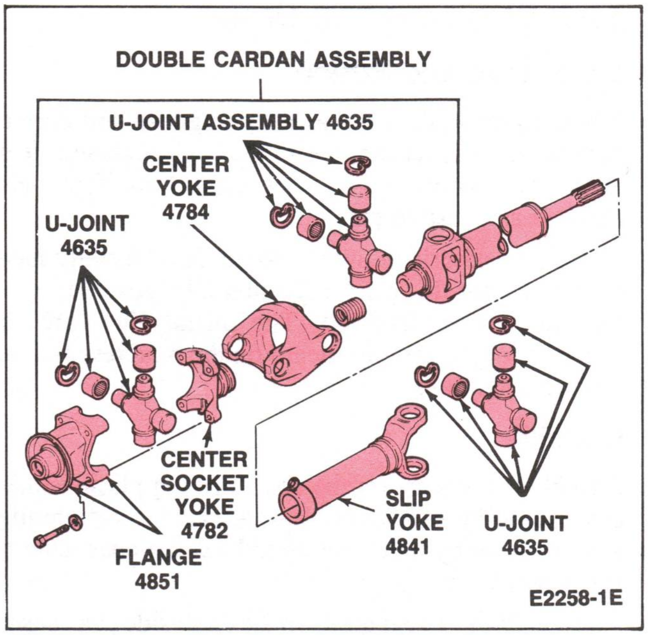


Figure 33 — Typical Double Cardan U-Joint

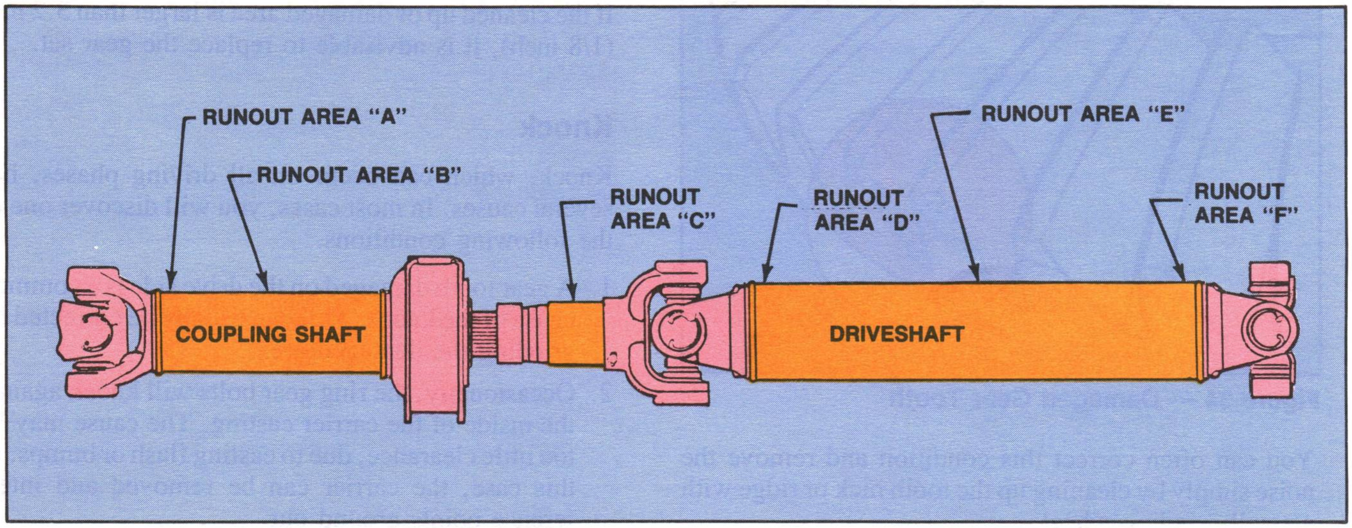


Figure 32 — Runout Check Locations for Typical Two-Piece Driveshaft

ANALYSIS OF GEAR NOISE

Gear Howl and Whine

When disassembling the axle to diagnose and correct gear noise, it is assumed that the tires, exhaust, trim items and station wagon roof racks have first been checked as possible causes.

The noises described under "Road Test" usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are, of course, the type of noise heard on the road test and the driving conditions.

Chuckle

Chuckle that occurs on the coast driving phase is usually caused by excessive clearance due to differential gear wear; or by a damaged tooth on the coast side of the pinion or ring gear.

Any damage to a gear tooth on the coast side can cause a noise identical to chuckle. Even a very small tooth nick or ridge on the edge of a tooth is enough to cause the noise (Figure 34).

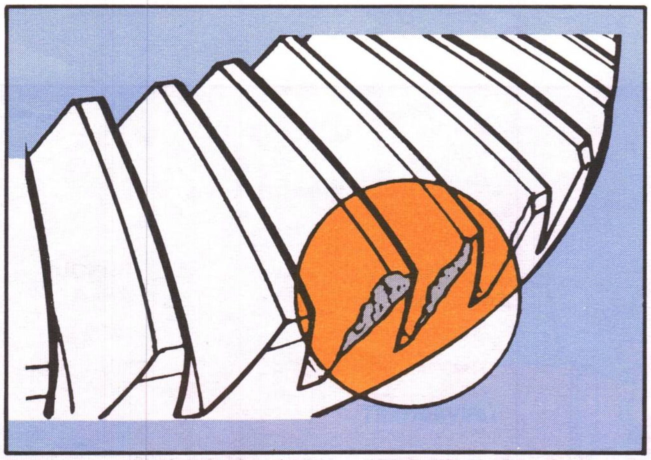


Figure 34 — Damaged Gear Tooth

You can often correct this condition and remove the noise simply by cleaning up the tooth nick or ridge with a small grinding wheel.

If either gear is scored or damaged badly, the gear set must be replaced. Also, if there is metal broken loose, the carrier and housing must be cleaned to remove particles that could cause damage later. Any other damaged parts in the axle must be replaced.

To check the gear set, remove as much lubricant as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth (Figures 34 and 35). Also look for cracks or other damage.

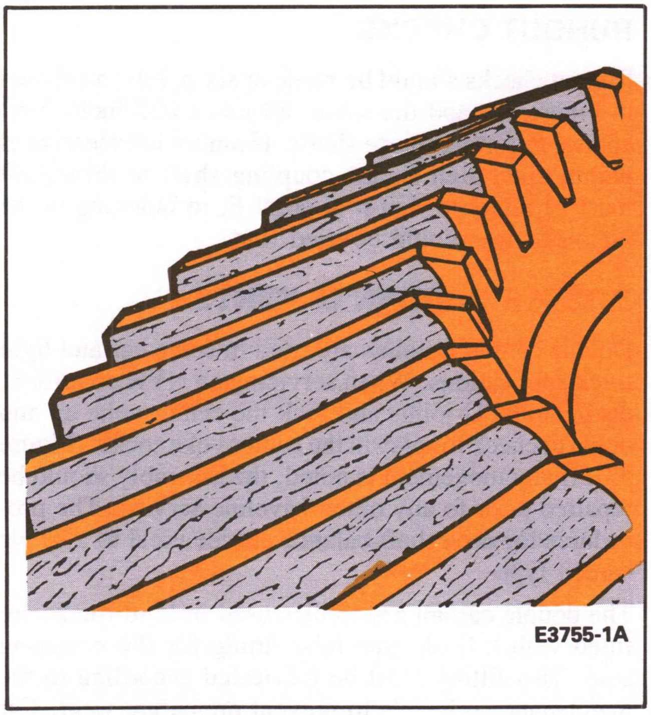


Figure 35 — Scored Gear Set

If the cleaned up or damaged area is larger than 3.2 mm (1/8 inch), it is advisable to replace the gear set.

Knock

Knock, which can occur on all driving phases, has several causes. In most cases, you will discover one of the following conditions.

1. A gear tooth damaged on the drive side is a common cause of the knock. This can usually be corrected by grinding the damaged area.
2. Occasionally, the ring gear bolts will knock against the inside of the carrier casting. The cause may be too little clearance, due to casting flash or bumps. In this case, the carrier can be removed and interference points ground out.

Another possibility is simply that one or more bolts are slightly backed out. Proper tightening will correct the condition.

3. Knock is also characteristic of excessive end play in the axle shafts. Up to 0.254 mm (0.010 inch) is allowed in most axles. However, it may be as high as 1.14 mm (0.045 inch); so that knock occurs even in design conditions. The frequency of knock will be less because the axle shaft speed is slower than the driveshaft.

NOTE: BE SURE TO MEASURE THE END PLAY WITH A DIAL INDICATOR; NOT BY FEEL. A "GUESSTIMATE" USUALLY FEELS LIKE FAR MORE END PLAY THAN THERE ACTUALLY IS.

AXLE SHAFT END PLAY CHECK (INTEGRAL AXLE)

1. Remove wheel and tire, brake drum or rotor.
2. Mount a dial indicator on the brake backing plate or caliper frame, and place the indicator stem on the axle shaft flange (Figure 36).

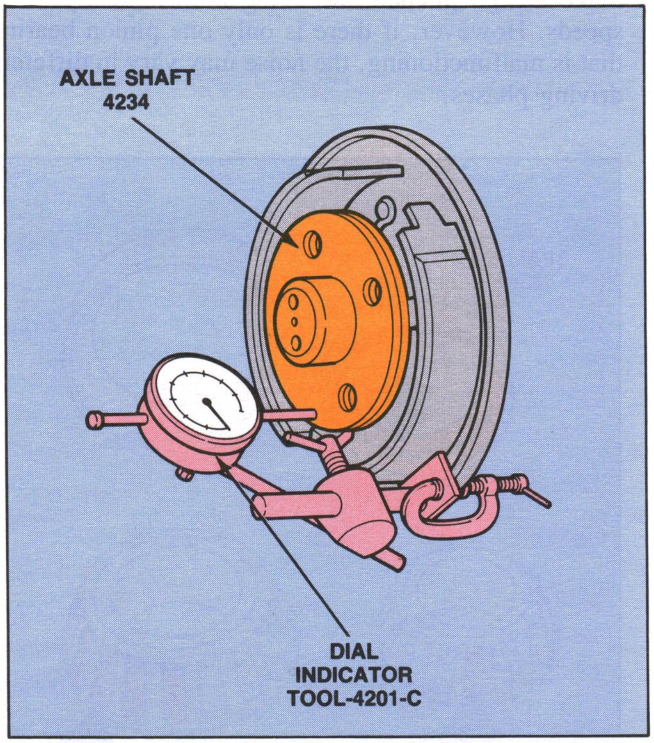


Figure 36 — Measuring Axle Shaft End Play

3. Push the shaft inward until it bottoms and zero the dial indicator.
4. Pull the axle outward until it bottoms again and read the total end play.
5. Remove the dial indicator and repeat steps 1-4 on the opposite side.

On the integral axle, end play is allowable up to 0.635 mm (0.025 inch), but can be reduced to 0.127 mm (0.005 inch). It is controlled by the C-washer that holds the shaft in the pocket of the side gear (Figure 37).

To reduce the clearance, cut a shim in the pattern of the washer and install it behind the washer. Do not reduce the end play to less than 0.127 mm (0.005 inch).

Clunk

Clunk is due to backlash in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, make a check of the total axle backlash as follows:

1. Raise the vehicle on a frame or twin post hoist so that the rear wheels are free.
2. Clamp a bar between the axle companion flange and a part of the frame or body so that the flange cannot move.
3. Lock the left rear wheel to keep it from turning.

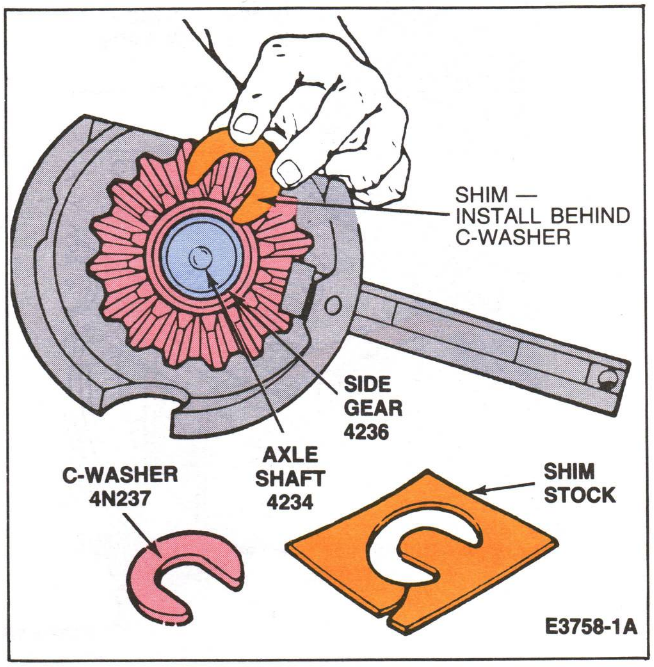


Figure 37 — Integral Axle End Play Correction

4. Turn the right wheel slowly until you "feel" it in a drive condition. Hold a chalk marker on the side of the tire 12 inches from the center of the wheel (Figure 38).

5. Turn the wheel the other way until you again feel the drive condition. Check again in two other places.

6. Measure the average length of the chalk marks; which are the total axle backlash. It should be one inch or less. If the backlash is within this limit, the clunk will not be eliminated by going into the axle.

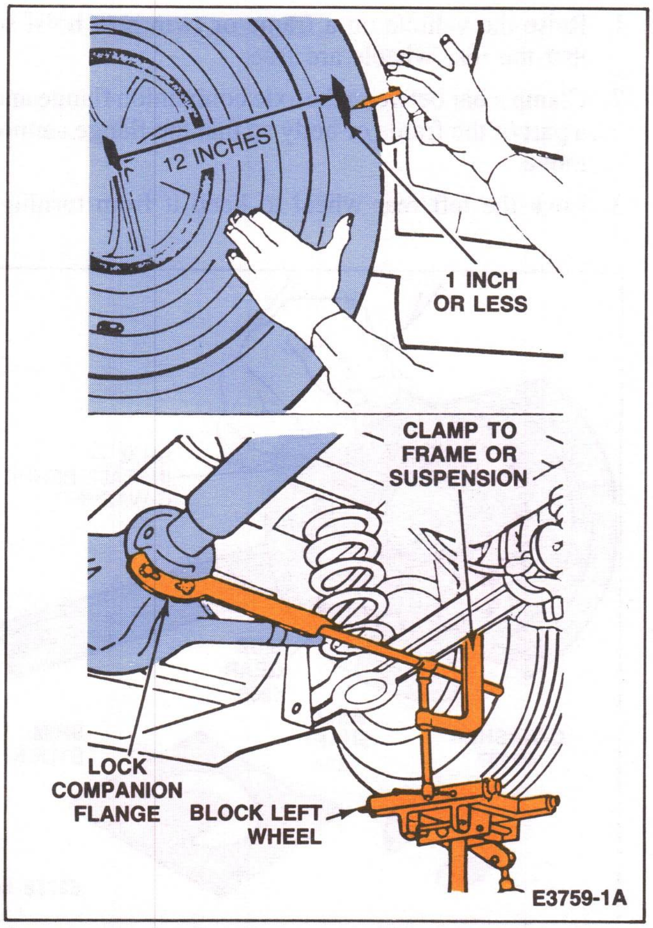


Figure 38 — Checking Total Axle Backlash

Check for these conditions if the backlash is excessive.

1. Elongation of the differential pinion shaft holes in the differential case.
2. Missing differential or side gear washer.
3. Galling of the differential pinion shaft and bore.

If none of the above conditions show up, there may be a loose fit of the axle shafts to the side gear splines. You should continue as follows until the correction is made.

4. Install new side gears and recheck the backlash.
5. Install two new axle shafts.
6. Replace the axle assembly.

Bearing Noise

Bearing malfunctions normally will be obvious at disassembly (Figure 39). As noted earlier, pinion bearings make a high pitched, whistling noise; usually at all speeds. However, if there is only one pinion bearing that is malfunctioning, the noise may vary in different driving phases.

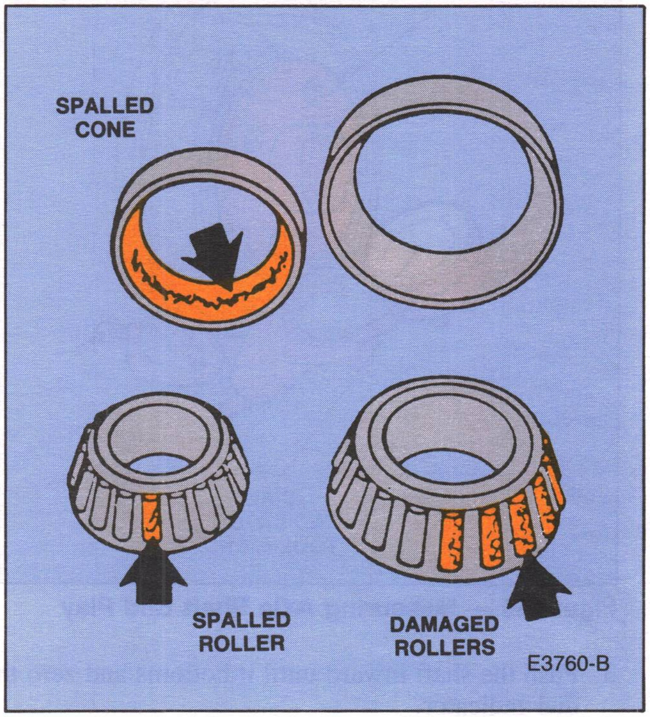


Figure 39 — Typical Bearing Malfunction

Pinion bearings are frequently replaced unnecessarily when correcting gear noise. They should not be replaced unless they are actually scored or damaged; or there is a specific pinion bearing noise. Examine the large end of the rollers for wear. If the original blend radius has worn to a sharp edge, the cone and roller assembly should be replaced.

Remember that the low-pitched rumble of a malfunctioning wheel bearing can be duplicated by a station wagon roof rack, or by tires.

AXLE NOISE

GEAR NOISE is the typical "howling" or "whining" of the ring gear and pinion due to an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

CHUCKLE is particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 64 km/h (40 mph) and usually can be heard all the way to a stop. The frequency varies with the speed of the vehicle.

KNOCK is very similar to chuckle; though it may be louder and occurs on acceleration or deceleration. The teardown will disclose what has to be corrected.

CLUNK may be a metallic noise heard when the automatic transmission is engaged in REVERSE or DRIVE, or it may occur when throttle is applied or released. It is caused by backlash somewhere in the driveline; it is "felt" or heard in the axle.

BEARING WHINE is a high pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings, which are operating at driveshaft speed. Roller wheel bearings may whine the same way if they run completely dry. Bearing noise occurs at all driving speeds; this distinguishes it from gear whine, which usually comes and goes as speed changes.

BEARING RUMBLE sounds like marbles being tumbled. This condition is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of driveshaft speed.

CHATTER on corners is a condition where the whole rear end vibrates only when the vehicle is moving. The vibration is plainly felt as well as heard. In conventional axles, extra differential thrust washers cause a condition of partial lockup that creates this chatter. Chatter noise on Traction-Lok axles can usually be traced to erratic movement between adjacent clutch plates and can sometimes be corrected with a lubricant change and the addition of a friction modifier.

SUSPENSION SYSTEMS

The suspension system is another common source for NVH concerns. With the addition of driver-adjustable or electronically-adjusted suspension systems, another entire family of potential NVH sources must be addressed. Because of the differences between the various systems, this book will only present a description of the air, automatic leveling and programmed ride control suspension systems. Additional information about suspension systems can be found in Section 14 of the Shop Manual.

AIR SUSPENSION

Description

The air suspension is an air-operated, microprocessor-controlled suspension system which replaces the conventional coil spring suspension and provides automatic front and rear load leveling.

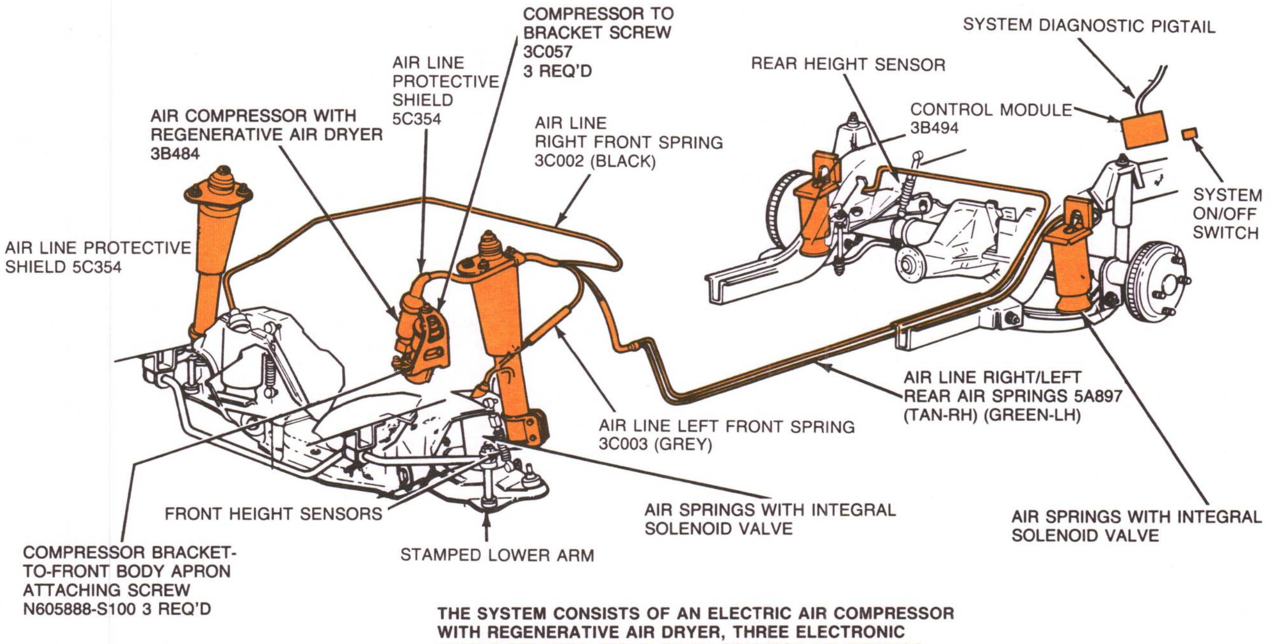
Four air springs, made of rubber and plastic, support the vehicle load at the front and rear wheels.

The front air springs are mounted to a spring pocket in the crossmember and on the lower suspension arms, similar to the conventional front spring system. The rear air springs are mounted ahead of the rear axle outside the body sub-frame side members and on the lower rear suspension arms, similar to the conventional rear spring system.

A single cylinder piston-type electrically operated air compressor, mounted on the LH fender apron, supplies the air pressure for operating the system. A regenerative-type dryer is attached to the compressor manifold. All airflow during compression or venting passes through the dryer. A vent solenoid, located on the compressor manifold, controls air exhaustion.

The airflow to the entire system is controlled by the interaction of the air compressor, solenoids, height sensors and control module. All the air-operated parts of the system are connected by nylon tubing.

The front and rear suspensions are very similar to a conventional coil spring suspension, except for a stamped front control arm and addition of a rear link-type stabilizer bar. Gas-pressurized front shock struts and rear shock absorbers are the same as for a conventional coil spring suspension.


COMPRESSOR TO BRACKET SCREW 3C057 3 REQ'D
SYSTEM DIAGNOSTIC PIGTAIL
AIR LINE PROTECTIVE SHIELD 5C354
REAR HEIGHT SENSOR
CONTROL MODULE 3B494
AIR COMPRESSOR WITH REGENERATIVE AIR DRYER 3B484
AIR LINE RIGHT FRONT SPRING 3C002 (BLACK)
SYSTEM ON/OFF SWITCH
AIR LINE PROTECTIVE SHIELD 5C354
AIR LINE RIGHT/LEFT REAR AIR SPRINGS 5A897 (TAN-RH) (GREEN-LH)
AIR LINE LEFT FRONT SPRING 3C003 (GREY)
FRONT HEIGHT SENSORS
AIR SPRINGS WITH INTEGRAL SOLENOID VALVE
AIR SPRINGS WITH INTEGRAL SOLENOID VALVE
COMPRESSOR BRACKET-TO-FRONT BODY APRON ATTACHING SCREW N605888-S100 3 REQ'D
STAMPED LOWER ARM
F3651-D

THE SYSTEM CONSISTS OF AN ELECTRIC AIR COMPRESSOR WITH REGENERATIVE AIR DRYER, THREE ELECTRONIC HEIGHT SENSORS, EIGHT QUICK CONNECT AIR FITTINGS, FOUR AIR SPRINGS WITH INTEGRAL SOLENOIDS, FOUR ONE-PIECE AIR LINES CONNECTING EACH SPRING TO THE COMPRESSOR AND A CONTROL MODULE WITH A SINGLE CHIP MICROCOMPUTER.

Figure 40 — Air Suspension System

AUTOMATIC LEVELING SUSPENSION

Description

The automatic leveling system is an addition to the standard rear suspension. It automatically adjusts the vehicle's trim height with varying vehicle loads.

This system consists of air adjustable rear shocks, a compressor assembly, air dryer with minimum retention valve, exhaust solenoid, compressor relay, rotary height sensor, microcomputer, wiring and nylon tubing.

The adjustable air shock is essentially a conventional shock absorber enclosed in an air chamber. These shocks are constructed with a rubber sleeve attached to the dust tube and shock reservoir. This makes a flexible chamber which will extend the shocks when air pressure in the chamber is increased. When air pressure is reduced, the weight of the vehicle collapses the shocks.

A single-cylinder piston-type electrically operated air compressor, mounted in the engine compartment on the LH fender apron, supplies the air pressure for operating the system. A regenerative-type dryer is attached to the compressor manifold. All airflow during raising or lowering of the vehicle passes through the dryer. A vent solenoid, located on the compressor manifold, controls air exhaustion. A minimum retension valve, located inside the air dryer, maintains pressure to the rear shocks to a minimum of 69-152 kPa (10-22 psi). A computer module receives and interprets signals from the height sensor and provides control signals to operate the compressor relay and vent solenoid.

The underbody height sensor is an electronic device that controls two basic circuits. These are the compressor relay coil ground circuit and the exhaust solenoid coil ground circuit.

To prevent continuous actuation of the compressor relay or exhaust solenoid circuits during normal ride motions, the microcomputer provides a continuous

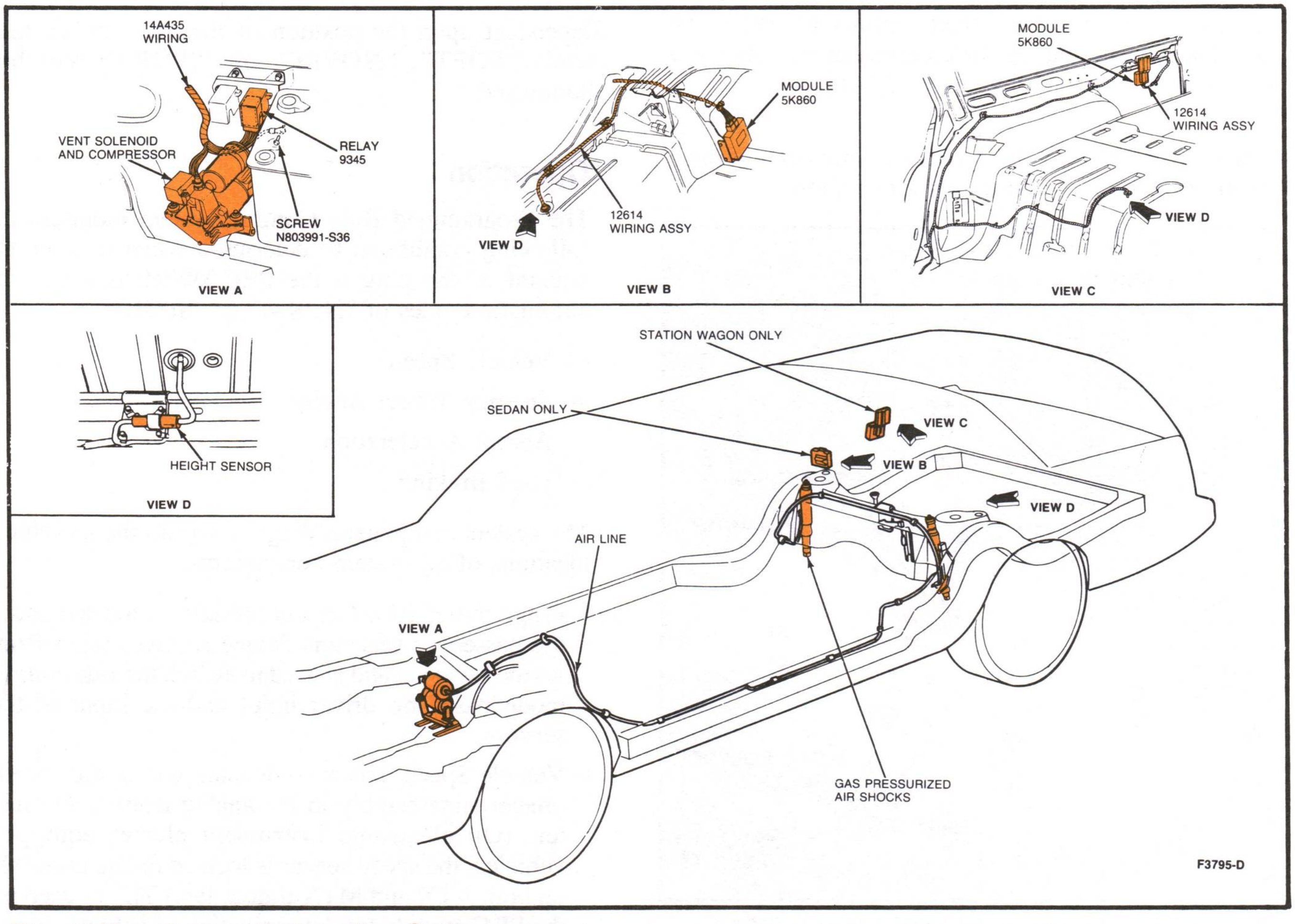


Figure 41 — Automatic Leveling System

7-13 second time delay before either circuit can be completed. The height sensor is mounted to the frame crossmember in the rear. The sensor actuator arm is attached to the rear upper LH control arm by a short link.

The microcomputer regulates the air compressor motor (through a relay), and vent solenoid to provide the air requirements of the shock absorbers. The module also provides power and ground to the rotary height sensor. It continuously monitors inputs from the height sensor and the ignition circuits. These inputs are used by the module to make vehicle leveling decisions which are then carried out by the air system components controlled by the module.

In addition, the module limits compressor run time and exhaust solenoid energized time to a maximum of two minutes and one minute, respectively. These time functions are necessary to prevent continuous compressor operation in case of a severe system leak or continuous exhaust valve operation. Turning the ignition off and on resets the electronic timer circuits to renew the maximum accumulating air compressor run time and continuous exhaust solenoid vent time.

For service, the module provides a series of self diagnostic tests through the use of a test lamp.

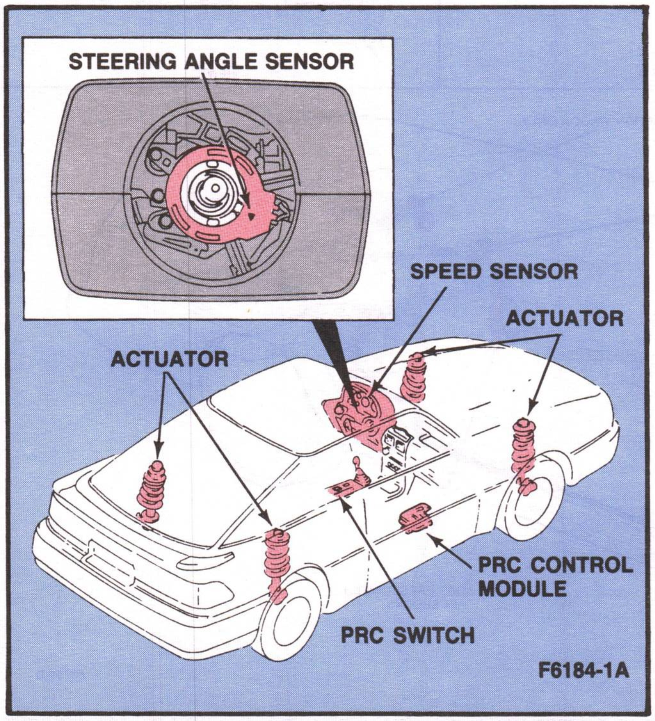


Figure 42 — Programmed Ride Control (PRC)

PROGRAMMED RIDE CONTROL

Description

The Programmed Ride Control (PRC) feature allows for the selection of soft, hard, and very hard combinations of damping control from the front and rear shock absorbers.

The PRC switch, located in the center console, allows selection for either the manual or both automatic control modes of the PRC Suspension.

- — Selection of "SOFT" will provide (plush) damping at all times and under all conditions.
- — Selection of "NORM" (Normal) or "SPORT" will engage the Automatic Adjusting Suspension feature. This provides combinations of "hard" or "very hard" damping dependent upon sensor inputs for vehicle speed, acceleration, braking, and cornering. This helps to control vehicle roll, pitch and dive, and thus also provides improved handling at high speed.

Dependent upon the position of the PRC switch the words "SOFT", "NORM", or "SPORT" will be illuminated.

Operation

The Programmed Ride Control System monitors the following conditions to determine when to alter the amount of damping if the PRC switch is set in the automatic modes of "NORM" or "SPORT":

- — Vehicle Speed
- — Steering Wheel Angle
- — Abrupt Acceleration
- — Hard Braking

The system components diagram shows the in-vehicle locations of all system components.

- Programmed Ride Control Module — located under the passenger seat; this device receives input from various sensors and is used to switch the ride control mode based on driver input and the input of the sensors.
- Vehicle Speed Sensor — located within the speedometer subassembly in the analog instrument cluster. (On electronic instrument cluster equipped vehicles, the speed sensor is located on the transaxle on both ATX and MTX transaxles.) This is used by the PRC module for determination of vehicle speed.

STEERING SYSTEMS

The steering system is a complex assembly which can contribute to NVH concerns in a number of ways. To simplify diagnosis, it is a good idea to separate the steering system into four sub-systems: the steering column, the steering gearbox assembly, the steering linkages and the power steering pump (on vehicles with power steering). The following chart outlines some of the possible sources of common NVH concerns related to the steering system. Refer to Section 13-01 of the Shop Manual for more detailed information.

STEERING SYSTEM DIAGNOSIS

CONDITION	POSSIBLE SOURCE	ACTION
• Feedback (Rattle, Chuckle, Knocking Noises in Steering Gear): A condition where roughness is felt in the steering wheel by the driver when the vehicle is driven over rough pavement.	• Column intermediate shaft joints loose/worn.	• Replace intermediate shaft assembly.
	• Loose tie rod end(s) and/or tie rod inner ball joints.	• Replace tie rod end(s) and/or tie rod assemblies. Refer to Section 13-46.
	• Steering gear mounting insulators and/or attaching bolts loose or damaged.	• Replace insulators and/or tighten attachment nuts to specification.
	• Column intermediate shaft connecting bolts loose.	• Tighten bolts to specification at gear 19-27 N•m (14-20 lb-ft) at column 27-40 N•m (20-30 lb-ft).
	• Loose suspension bushings/ fasteners or ball joints.	• Tighten suspension fasteners, replace worn bushings, or replace ball joints.
	• Check column conditions.	• Refer to Section 13-06 for Steering Column Diagnosis.
• Poor Returnability — Sticky Feel: A condition noticed when the steering fails to return to center following a turn without manual effort from the driver. In addition, when the driver returns the steering wheel to center, it may have a sticky or catchy feel.	• Improper tire pressure.	• Adjust tire pressures.
	• Improper tire size or different type.	• Replace as required.
	• Misaligned steering column or column flange rubbing steering wheel and/or flange.	• Align column. Refer to Section 13-04.
	• Column intermediate shaft universal joints binding.	• Replace intermediate shaft assembly.
	• Check for boot tears and/or evidence of binding or damage to tie rod ends or ball joints.	• Replace as necessary.
	• Damaged/worn front suspension components.	• Inspect struts and lower control arm ball joints. Refer to Section 14-05 for front suspension replacement.
	• Improper wheel alignment.	• Adjust toe as required.
	• Column bearing binding.	• Replace bearing.
	• Contamination in system.	• Flush power steering system.

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STEERING SYSTEM DIAGNOSIS — Continued

CONDITION	POSSIBLE SOURCE	ACTION
• Heavy Steering Efforts, Poor Assist or Loss of Assist: A condition recognized by the driver while turning corners and during parking maneuvers.	• Low pump fluid.	• Fill as required and check for system leaks.
	• Gear assembly external or internal leakage.	• Refer to Section 13-46 for Rack and Pinion Power Gear Diagnosis.
	• Pump external leakage.	• Refer to Section 13-51, Pump Diagnosis.
	• Improper drive belt tension.	• Adjust belt tension.
	• Hose or cooler external leakage.	• Service/replace as necessary.
	• Improper engine idle speed.	• Adjust idle.
	• Pulley loose or warped.	• Replace pulley.
	• Pump flow/pressure not to specifications.	• Refer to Section 13-51.
	• Hose or cooler line restriction.	• Clean or replace as necessary.
	• System contamination.	• Inspect system for foreign objects, kinked hose, etc. — Flush system. — Refer to Section 13-51.
	• Plugged valve screen.	• Prior to rebuilding a Oil pump, examine the valve screen for contamination. Replace all valves which have plugged or contaminated valve screens.
• System Noise: Chirp or squeal when steering wheel is cycled lock to lock	• Loose or worn pump belt.	• Adjust to specification, or replace as required.
• Pump whine or moan	• Fluid aeration.	• Purge system of air. Refer to Purging Procedures in this Section.
	• Low fluid.	• Check fluid level. Correct as required.
	• Pump brackets loose or misaligned.	• Check bracket(s), bolt torques, and bracket alignment. Correct as required.
	• Power steering hose(s) grounded.	• Check for component grounding, and correct as required.
• Other suspected pump noises	• Internal pump discrepancies.	• Refer to Section 13-51.
• Gear Hiss	• Check column intermediate shaft and gear for alignment and binding.	• Adjust column and/or intermediate shaft. Refer to Section 13-06.
	• Check for grounded or loose boot at dash panel.	• Align boot or tighten fasteners as required. Refer to Section 13-06.
	• Input shaft and valve assembly.	• Replace — Only if noise is extremely objectionable. Refer to Section 13-46 for Rack and Pinion Power Gear Diagnosis.

STEERING SYSTEM DIAGNOSIS — Continued

CONDITION	POSSIBLE SOURCE	ACTION
• Noise/Rattle (Steering Column)	• Loose bolts/attaching brackets. • Looseness of ball bearings or insufficient lube. • Steering shaft insulators cracked or dry. • Flex coupling compressed or extended.	• Tighten to specification. • Lube or replace bearings. • Replace or lube insulators as required. • Reposition shaft assembly to flatten flex coupling.
• Noise/Squeak or Cracks (Steering Column)	• Dry bushings. • Loose or mispositioned shrouds. • Steering wheel rubbing against shrouds. • Dry shift lever grommets. • Insufficient lube on speed control slip ring. • Upper or lower bearing sleeve out of position.	• Lube shaft seal and shift tube seal. • Tighten or reposition shrouds as required. • Replace shroud(s) or wheel or reposition shrouds as required. • Lube grommets. • Lube slip ring. • Reposition bearing sleeve.
• Power Steering	• Check belt for proper tension or glazing.	• Tighten or replace belt as required.
• Pump Noisy	• Low fluid level and possible leakage.	• Refill to specified level. Purge air from system. Check for leaks. Service as required.
• Swish Type Noise	• Fluid flow into the bypass valve of pump valve housing with fluid temperature below 54°C (130°F).	• Normal noise.
• Whine Type Noise	• Aerated fluid, or cam contour damaged. • Check valve cover O-ring seal.	• Purge system of air. If condition not resolved. Replace rotor assy. • Replace valve cover O-ring seal.
• Clicking Mechanical Type Noise	• Pump slippers too long, excessive wear of pumping elements. Excessive slipper to slot clearance, or out of square slipper springs.	• Replace rotor assembly.
• Chatter Type Noise	• Chipped corners on rotor outside diameter or distorted slipper ring.	• Replace rotor assembly.
• Other Causes of Noise	• Improper assembly of components such as slippers. • Imperfections on rotor outside diameter or rotor end surface. • Damaged rotor splines. • Hairline crack on cam inner surface. • Interference between rotor and cam. • Excessively worn or scored pumping elements and pressure plates.	• Rebuild pump and replace components as required. • Replace rotor assembly. • Replace rotor assembly. • Replace cam rotor assembly. • Replace rotor assembly. • Replace rotor assembly and pressure plates.

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ENGINE RUN-UP TEST

Install a tachometer in the vehicle so that engine speed can be properly correlated with vehicle speed. The engine speed is brought up to the problem rpm with the vehicle stationary, and the transmission in PARK or NEUTRAL. Then with the service brake applied, try the same procedure in DRIVE range.

It is important to note that while making this test in the DRIVE range on automatic transmission-equipped vehicles, do not hold the throttle open for more than five seconds at a time, because of excessive converter heat-up. To cool the converter, place the selecter lever in NEUTRAL and run the engine at 1000 RPM for about 15 seconds.

On manual-shift transmissions, run the engine up to the problem rpm with the transmission in NEUTRAL with clutch engaged and disengaged. On automatic transmission, if the problem is encountered in either PARK or NEUTRAL, the disturbance may be caused by the engine or engine accessories, such as an air conditioner compressor, flywheel torque converter, or an input component within the transmission.

However, if the problem exists in DRIVE range, the disturbance may be caused by bound-up engine mounts and/or exhaust system components.

ENGINE ACCESSORY CHECK

Watch the drive belts (Figure 43), with the engine running in NEUTRAL and at the problem speed. If one of the belts experiences severe belt whip at this speed, this accessory, or drive system may contribute to the problem.

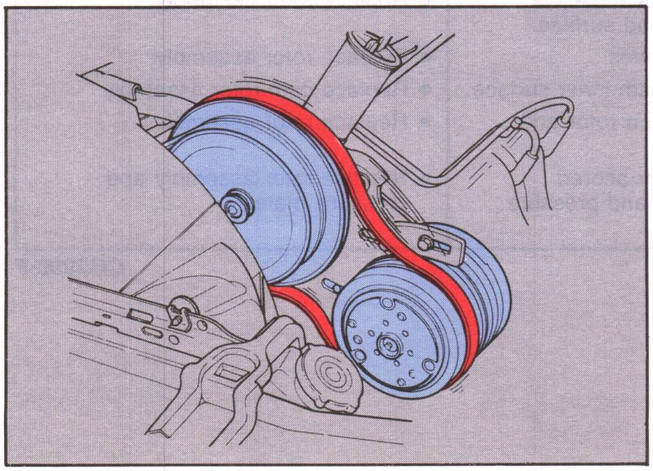


Figure 43 — Check for Belt Whip

If noise occurs in PARK or NEUTRAL, check all accessory attaching bolts for proper torque (Figure 44).

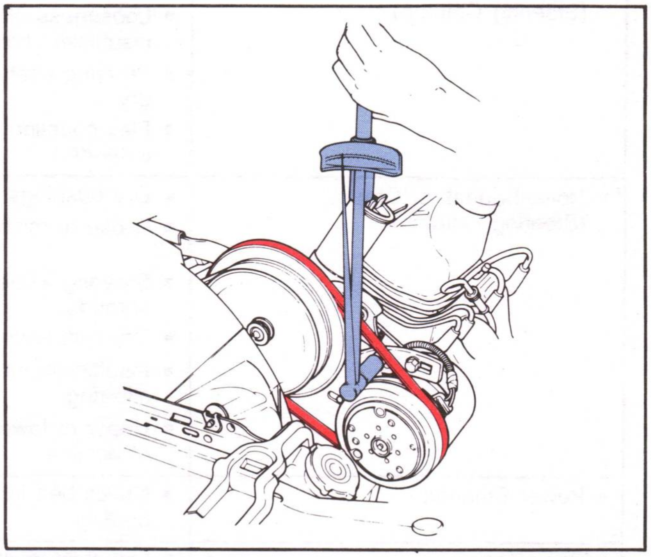


Figure 44 — Checking Accessory Mountings

Visually inspect all drive pulleys, belts, and pulley alignments. (Pulleys must be properly aligned. Check belt tensions.) Any damage in the accessory driveline system could initiate vibration. Bent or nicked pulleys may require replacement. Badly worn, frayed or nicked belts (Figure 45), must be replaced.

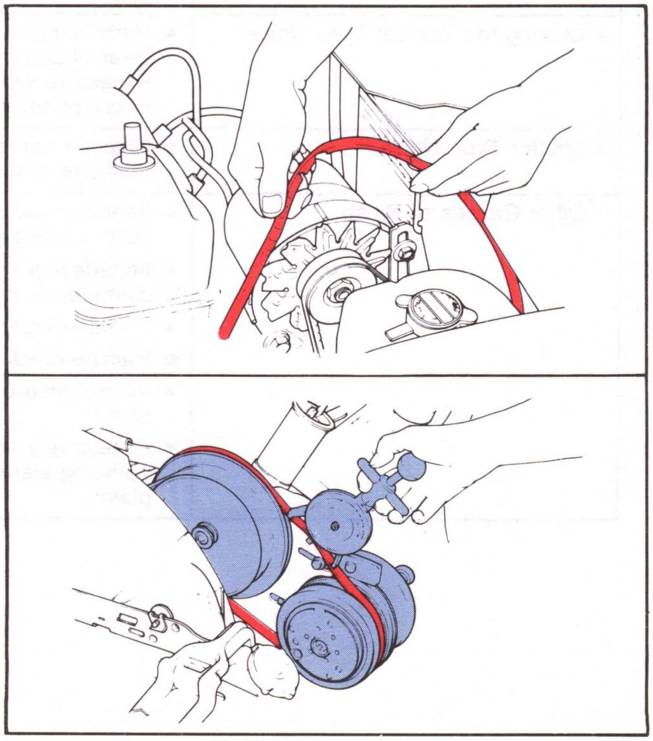


Figure 45 — Checking Belt Tension and Condition

Watch the drive pulleys at idle speed (Figure 46). Any pulley that exhibits radial or axial runout in excess of 1/8 inch, must be replaced.

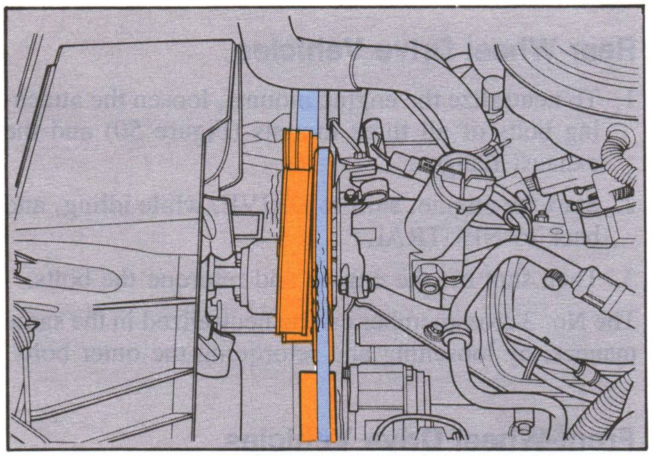


Figure 46 — Inspecting Pulley Runout

If inspection of the drive belts and pulleys does not indicate a defect the belts should be removed one at a time (Figure 47), and the engine run-up test repeated. If a sudden improvement is indicated, inspect the rotating portion of the component for worn or damaged parts and repair as required.

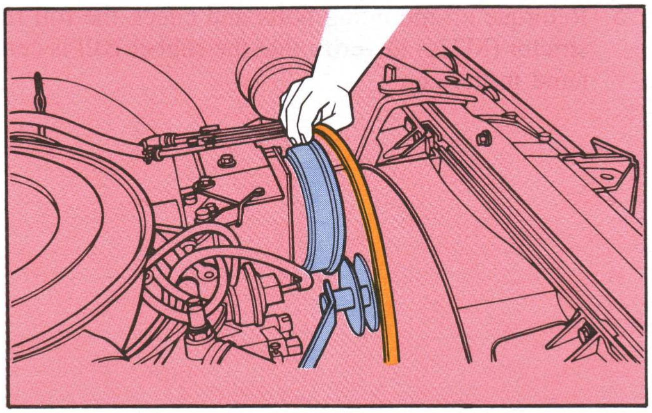


Figure 47 — Removing Drive Belts

If the removal of all drive belts does not improve the condition, remove belt-driven components from their brackets one at a time and repeat the run-up test. Under certain conditions, a component and its bracketry may produce a noise or vibration even when not driven by the belt. This is the same principle as a tuning fork (Figure 48). By removing the components one at a time, you should be able to isolate the cause. Refit the brackets and components and carefully torque all bolts to specification.

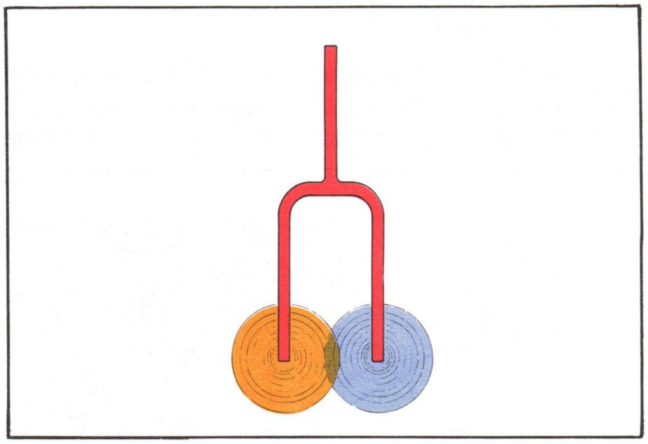


Figure 48 — Vibration Induced Noise

In some applications, a pulsating boom or drone may be present at certain engine speeds. This has been found to be caused by pulley ratio variations between two components driven by the same belt. Consult the TSB index for articles that will provide service part numbers for replacement pulleys.

If the vibration is traced to the water pump and fan area, (Figure 49), removal of the fan will further define the problem. If the vibration is corrected, make certain there are no burrs or foreign materials on any of the mating surfaces, and try reseating the assembly before replacing any parts. Vibration in the water pump can be caused by a damaged or bent shaft, faulty bearing, or unbalanced impeller.

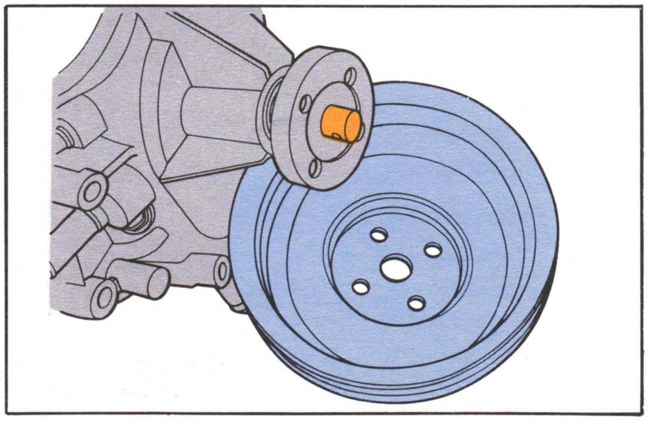


Figure 49 — Inspecting Water Pump Shaft

If after eliminating all accessory drive components and neutralizing the engine mounts and exhaust system the condition is still present, the source of the variation is in the engine, torque converter or clutch. Replace components one at a time to isolate the exact cause.

ENGINE MOUNTS AND EXHAUST SYSTEMS

ENGINE MOUNTS

Often an abnormal vibration is caused by a component such as an engine mount. If it has become distorted, it may act as a riding component and may not restrict the vibration level as it should. Grounded or abnormally strained exhaust system, and hangers, will also lead to this condition.

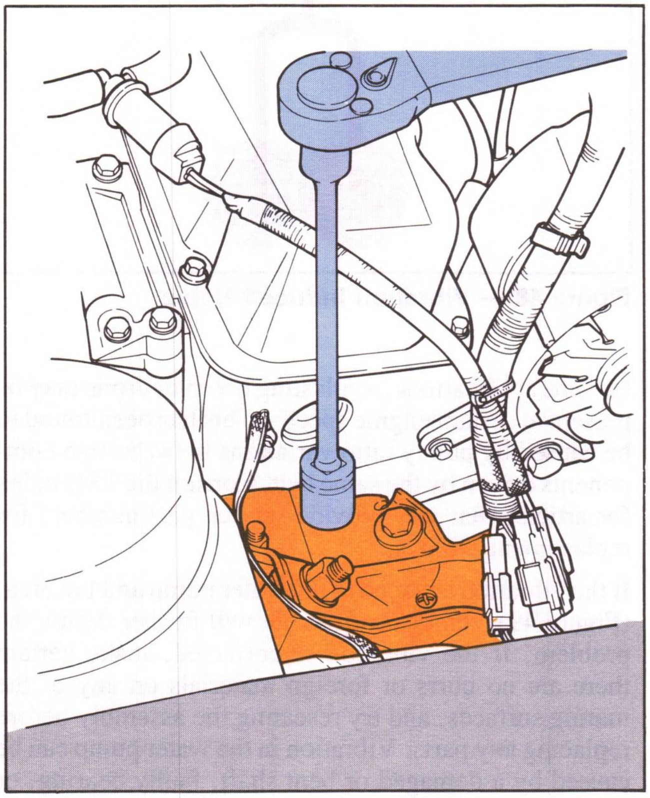


Figure 50 — Neutralizing Engine Mounts

Rear Wheel Drive Vehicles

1. To neutralize the engine mounts, loosen the attaching bolts of all three mounts (Figure 50) and the exhaust flanges.
2. Start the engine, shift to DRIVE, while idling, and back to NEUTRAL.
3. Then shut off the engine and retorque the bolts.

The No. 3 crossmember can be neutralized in the same manner, by loosening and retorquing the outer bolts.

Front-Wheel Drive Vehicles

1. Place a floor jack and wood block under the extreme left end of the engine oil pan.
2. Raise the jack enough to relieve engine and transaxle weight from the mounts.
3. Loosen both left mounting supports and the roll restrictor (MTX).
4. Shake the engine by hand to neutralize the engine mounts and lower the jack.
5. Retorque all mounting bolts and check the roll restrictor (MTX) to verify that the rubber ball is centered in the cup.

ENGINE MOUNTS AND EXHAUST SYSTEMS

EXHAUST SYSTEM

To neutralize the exhaust system (Figure 51), remember that the system must be hot because thermal expansion of the pipes will strain hangers that have been tightened down cold. While the exhaust system is at its normal operating temperature, loosen all hangers and re-position, as required, so that they hang free and straight.

Loosen the flanges at the manifolds (Figure 50), then start the engine. Shift to DRIVE, while idling, and back to NEUTRAL. Shut off the engine and retorque all flange and hanger bolts. Check to be sure that a grounding condition does not exist, and that adequate clearance does exist along the entire length of the exhaust system.

BODY MOUNTS

Grounded and loose frame mounts and body mounts may be the cause of some NVH problems. Therefore, inspect frame mounts at the No. 1 crossmember for grounding or twisting. Also, check the number three body mounts to be sure that only rebound bumpers are used.

If these conditions exist, loosen all the body mounts. Then replace the mounts that are missing or torn. The next step is to align all body mounts, and shim any existing gap between the mount and the body to obtain a uniform contact on all mounts. The last step is to torque all mounts to specifications.

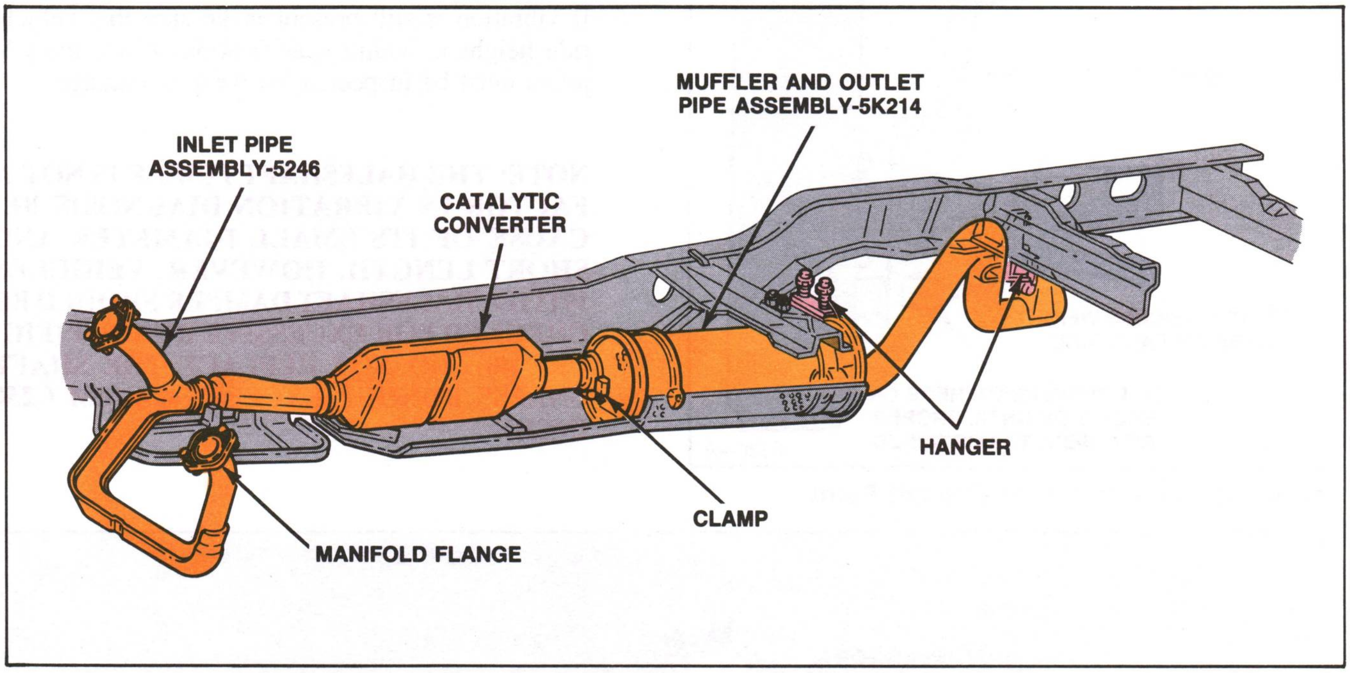


Figure 51 — Typical Exhaust System Layout

FRONT-WHEEL DRIVE

The halfshaft assemblies used in front-wheel drive vehicles are subject to conditions similar to the driveline of rear drive vehicles. The major difference is that the halfshaft rotates at about 1/3 the speed of a driveshaft. Because of this, vibration conditions may feel very much like tire imbalance or runout during the road test.

ISOLATING VIBRATION

1. To isolate the condition, raise one front wheel from the floor by placing a jack under the ball joint (Figure 52).

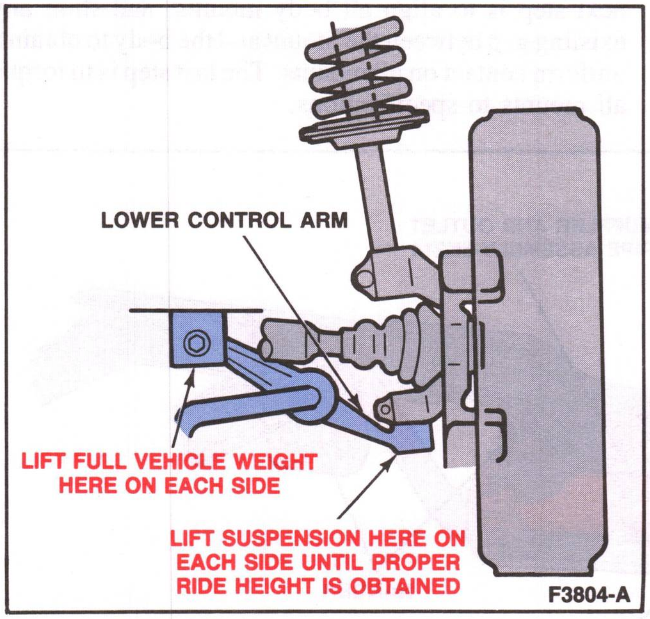

LOWER CONTROL ARM
LIFT FULL VEHICLE WEIGHT HERE ON EACH SIDE
LIFT SUSPENSION HERE ON EACH SIDE UNTIL PROPER RIDE HEIGHT IS OBTAINED
F3804-A

Figure 52 — Front Suspension Lift Point

2. Remove the wheel and tire and secure the brake rotor with the lug nuts.
3. Start the engine and increase speed to 1/2 the speed that vibration was noted during the road test.

CAUTION: DO NOT EXCEED 55 KM/H (35 MPH) DURING THIS TEST. OVERSPEEDING OF THE CV JOINTS COULD CAUSE DAMAGE OR PERSONAL INJURY.

4. If vibration persists, repeat Step 3 with the brake rotor removed. If vibration is now noticeably reduced the brake rotor is the source of imbalance.
5. If vibration is still present make sure that vehicle ride height is within specification. If so, the CV joints must be inspected for wear or damage.

NOTE: THE HALFSHAFT ITSELF IS NOT A FACTOR IN VIBRATION DIAGNOSIS BECAUSE OF ITS SMALL DIAMETER AND SHORT LENGTH. HOWEVER, VEHICLES WITH A HALFSHAFT DAMPER SHOULD BE CHECKED FOR EXCESSIVE RUNOUT (FIGURE 40). DO NOT REPLACE THE SHAFT UNLESS RUNOUT EXCEEDS 6.4 MM (.250 INCH).

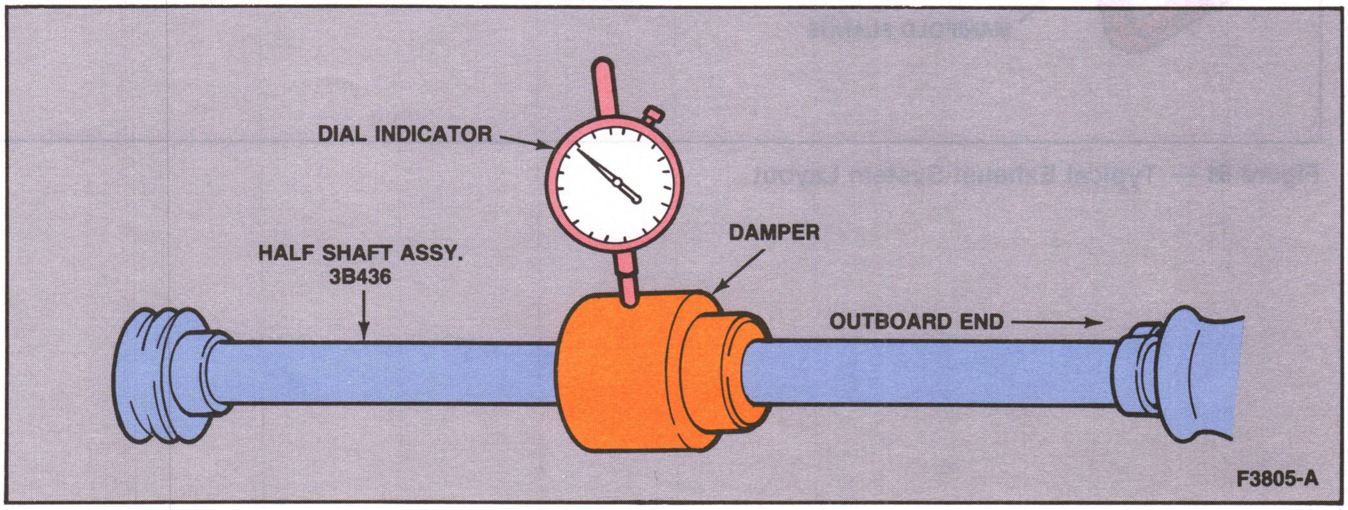


Figure 53 — Damper Halfshaft Runout Check

FRONT-WHEEL DRIVE

During normal driving conditions, the CV joints are subjected to constant changes in angularity. Worn or damaged CV joints can be isolated during the road test by noting changes in steering angle or ride height and the effect that it has on the vibration or shudder condition.

If the condition becomes noticeably worse during turns the outer CV joint is suspect. However, if the condition only changes with ride heights the inner CV joint is the probable source.

Once you have determined that a CV joint is defective consult Section 15 of the Shop Manual for complete service instructions.

NOTE: HALFSHAFTS ARE NOT BALANCED AND GENERALLY DO NOT CONTRIBUTE TO ROTATIONAL VIBRATION DISTURBANCES.

DIAGNOSIS

NOTE: CV JOINTS SHOULD NOT BE REPLACED UNLESS DISASSEMBLED AS OUTLINED AND INSPECTION REVEALS UNUSUAL WEAR.

Noise and Vibration in Turns:

Clicking, popping or grinding noises while turning may be caused by any of the following conditions:

- Inadequate or contaminated lubrication in inboard or outboard CV joints.
- Loose CV joint boot clamps.
- Another component contacting halfshaft assembly.
- Worn, damaged or improperly installed wheel bearing.

Vibration at Highway Speeds:

This may be caused by:

- Out of balance front wheels or tires.
- Out of round front tires.
- Improperly seated outboard CV joint in front wheel hub.

Shudder or Vibration During Acceleration:

This may be caused by:

- Excessively worn or damaged inboard or outboard CV joint.

Undercoating and Rustproofing:

Extreme care must be taken during undercoating and rustproofing procedures to protect CV joint boots from coating materials. Foreign materials on the rubber boot "accordion" could cause early failure.

Additional information can be found in Section 15-22 of the Shop Manual.

FOUR-WHEEL DRIVE

Diagnosis of four-wheel drive symptoms is generally lumped together with Noise, Vibration and Harshness (NVH). NVH is covered extensively in Section 18 of the Truck Shop Manual. There are some important points to understand, specifically when it comes to the diagnosis and service of four-wheel drive vehicles. Consider that a four-wheel drive vehicle has two drivelines instead of one so there are twice the number of potential driveline problems that face a 4x4 technician. The purpose of this section is to present diagnosis from a 4x4 point of view, and cover some important points to be aware of, without repeating the thorough information already contained in the Shop Manual.

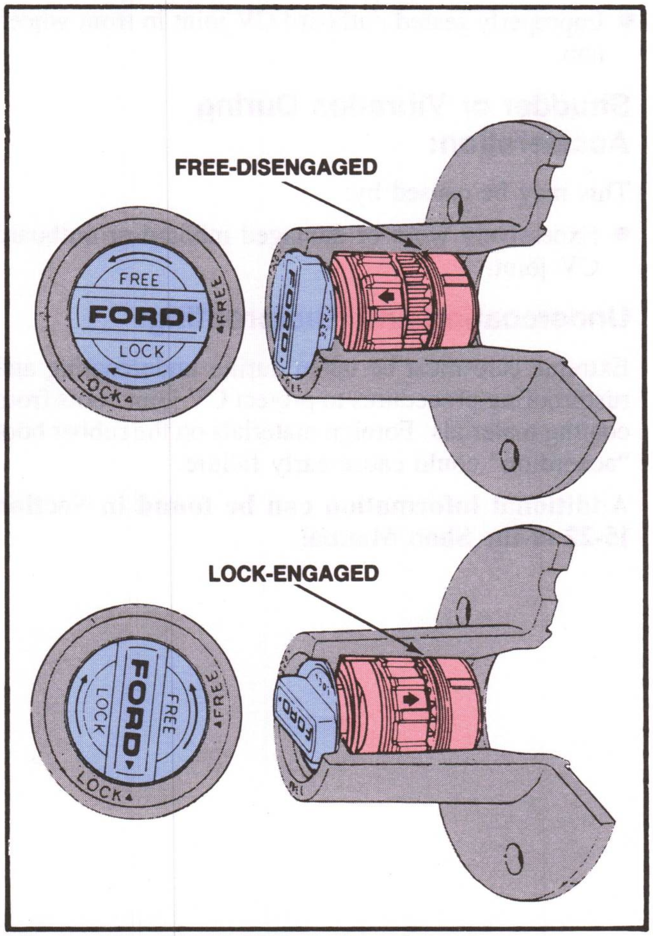


Figure 54 — Turning Free-Running Hubs to Locked Position

FRONT HUBS

Front hub noise, or difficulty in actuation of the front hubs, is a common problem caused by seal leakage. Water and/or dirt entering the hub area can cause corrosion and destroy the lubricating film over the moving components.

Free-wheeling hubs can make a ratcheting noise caused by the inability of the components to lock together. In a situation like this, the hub would have to be disassembled and the components cleaned and lubricated. Any burrs on the hub gear teeth should be filed as necessary to assure easy movement between the locking components. Seal installation is critical in assuring a non-leaking joint. Use special tools if they are called for, and take extreme care not to damage the rubber lip.

A ratcheting sound from an automatic locking hub may indicate that the opposite hub is not disengaging.

FLUID CONTAMINATION

Fluid contamination, lack of driveline lubrication and improper lubricant are often problems that are found with 4x4 vehicles, especially those that are involved in commercial farming, mining and constant off-road running. Ford 4x4 vehicles are built for tough work, and the heavy duty F-250 and F-350 pickups that are built for these applications can handle just about anything. But they require the proper lubricants and maintenance, as stated earlier in the free-running hub and axle sections. When a truck is operated in water or mud that gets over the top of the axle housing, hubs, wheel bearings, universal joints and differential housing should be serviced on a daily basis to assure that they are not contaminated. Tough work requires the proper maintenance. Also, make sure that the proper Ford recommended lubricants and fluids are used to assure long-running, dependable operation. Use of lubricants and fluid other than those specified can cause improper operation, accelerated wear, and possible component damage.

WIND NOISES

What is wind noise? Any type of noise that a customer hears that is caused by wind turbulence or air leaks. During the past several years, there have been numerous design and engineering actions taken that affect the sound characteristics of our current model carlines. The aero styling, limousine doors, and flush glass on all the restyled car lines greatly reduces drag, thereby reducing air turbulence as the vehicle is being operated. In addition, there have been other actions taken that also reduce the overall level of noise in our vehicles:

- Current tire tread design reduces road noise.
- Improved sound packages reduce road and engine noise.
- Automatic overdrive transmission reduces engine speeds, which also reduces engine noise.
- Improved tubular design weatherstrips provide increased sealing capabilities on irregular surfaces.

As a result of these actions, all our carlines have much less overall ambient noise in the passenger compartment. However, on some of our car lines that have not as yet been restyled (such as the Lincoln Town Car, Grand Marquis and Crown Victoria), the air turbulence noise is more noticeable on the current models that it was on those same models produced several years ago. In addition, any air leaks that occur on these models will be much more noticeable.

How do I handle a customer complaint on an older styled car line?

Road test the vehicle with the customer and determine if the sealing systems are functioning properly, and whether or not there are any leaks.

Suppose there is an excessive noise level in the vehicle. How can I accurately diagnose the wind noise and road noise?

First you have to understand some basic body sealing theory. The following illustration shows the effects of ram air on the sealing systems.

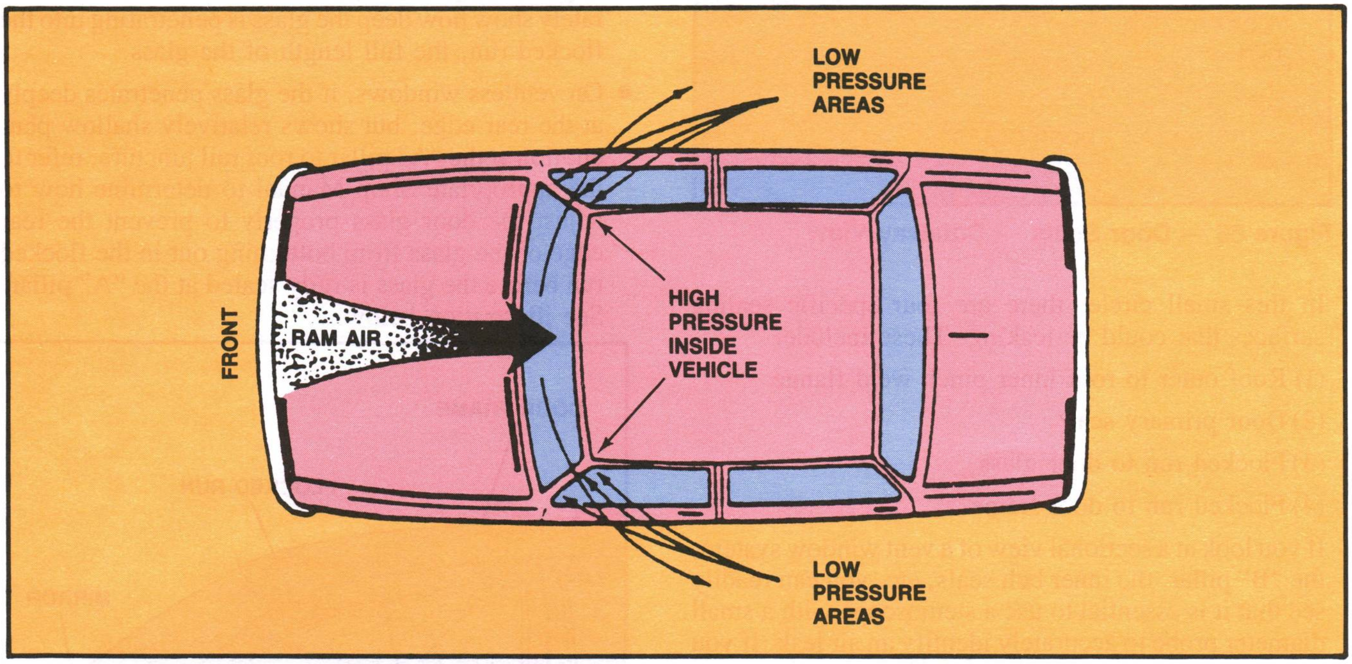


Figure 55 — Effects of Ram Air on Sealing System

- The faster the vehicle is traveling, the lower the pressure will be in the door window sealing envelope.
- The greater the step-off between the ourter surface of the "A" pillar and the door glass, the lower the pressure will be along the "A" pillar and the door glass.

Air leakage at the front door seals is air leaking out of the vehicle, due to the high pressure inside the vehicle versus the low pressure on the outside of the door window.

The following illustration is a cross-sectional view of a Lincoln-Town Car front door and roof rail at about the midway point between the "A" and "B" pillars.

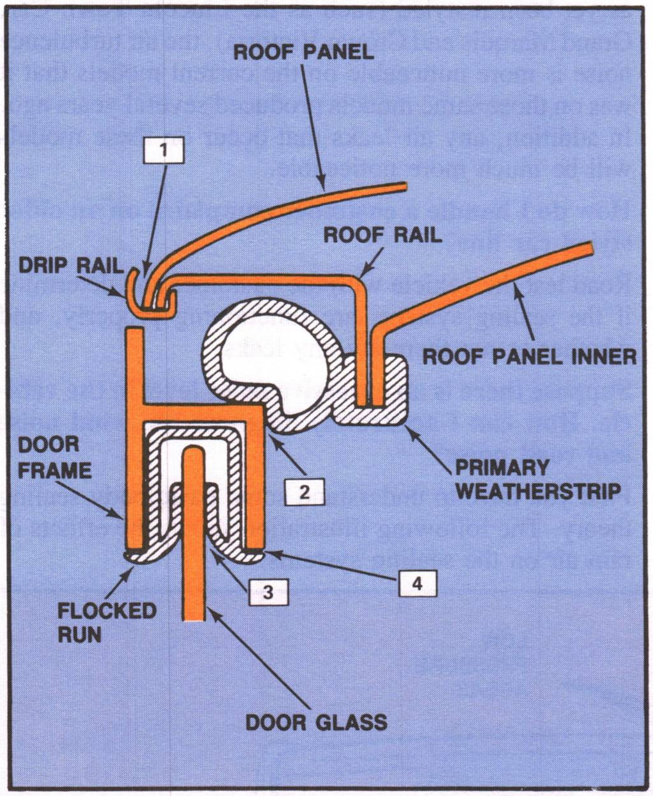


Figure 56 — Door Seals — Cutaway View

In this small circle, there are four specific sealing surfaces that could be leaking. These include:

(1) Roof outer to roof inner pinch weld flange

(2) Door primary seal

(3) Flocked run to door glass

(4) Flocked run to door frame

If you look at a sectional view of a vent window system, the "B" pillar, the inner belt seals, etc. you can readily see that it is essential to use a stethoscope with a small diameter probe to accurately identify an air leak. If you understand where each of these sealing systems are located, you can place the stethoscope probe at each of the specific sealing surfaces and locate the leak areas that are causing the complaint.

On the Lincoln Town Car, Grand Marquis and Crown Victoria, any leaks in the static seals in the roof rail or "B" pillar are noticed as an air leak from the seat belt opening in the "B" pillar. Leaks around the windshield are quite obvious with a stethoscope, and are relatively easy to resolve by applying liquid butyl sealer in the leak area.

Now that we know how to locate the air leaks, how do we fix them?

We have developed two hand-outs which are preliminary copies of TSB articles that will be out in the near future. These handouts will cover the recommended repair techniques for the Lincoln Town Car and Grand Marquis/Crown Victoria.

Additional tips for diagnosing wind noise — all car lines

When you encounter an air leak between the door glass and the flocked run, it is usually caused by insufficient glass penetration into the flocked run. A quick and easy way to determine door glass penetration is outlined below:

- Raise the door glass to the full up position.
- Using a crayon-type marker, scribe a line on the outer surface of the glass at the flocked run.
- Lower the door glass. Note the distance from the edge of the glass to the scribed line. This will accurately show how deep the glass is penetrating into the flocked run, the full length of the glass.
- On ventless windows, if the glass penetrates deeply at the rear edge, but shows relatively shallow penetration at the "A" pillar to roof rail juncture, refer to the appropriate Shop Manual to determine how to adjust the door glass properly to prevent the rear edge of the glass from bottoming out in the flocked run before the glass is fully seated at the "A" pillar. See illustration below.

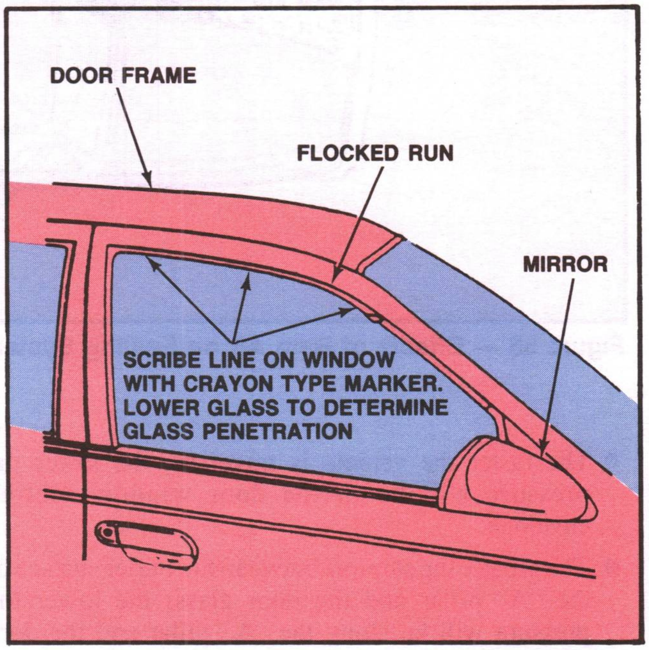

DOOR FRAME
FLOCKED RUN
MIRROR
SCRIBE LINE ON WINDOW WITH CRAYON TYPE MARKER. LOWER GLASS TO DETERMINE GLASS PENETRATION

Figure 57 — Determining Door Glass Penetration

- When you encounter an air leak at the belt seal, use a business card or matchbook cover, and insert the edge between the door glass and the inner belt seal. If the card inserts readily, the seal is mispositioned too far away from the glass. See illustration below:

- To correct this condition, remove the door trim panel, and rework the door trim panel mounting stools or the door inner panel as appropriate to achieve a tight fit of the inner belt seal to the door glass.

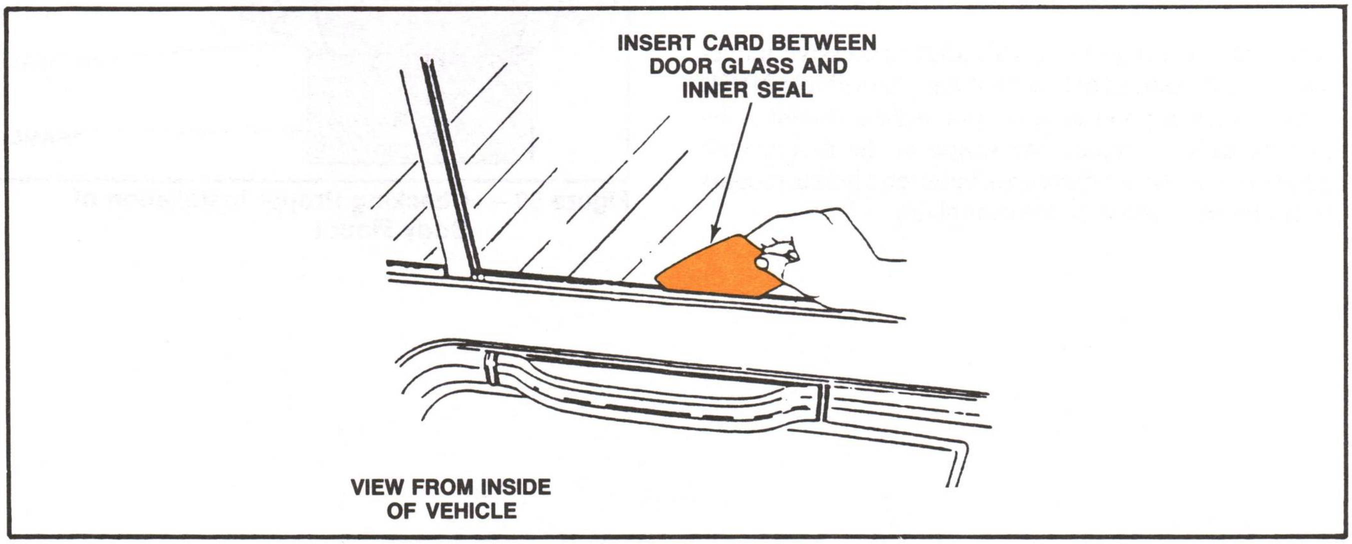

INSERT CARD BETWEEN DOOR GLASS AND INNER SEAL
VIEW FROM INSIDE OF VEHICLE

Figure 58 — Checking for Air Leak at Belt Seal

BODY MOUNTS

Body mounts, engine or transmission mounts, and exhaust mounts can all contribute to NVH concerns. When performing a visual inspection of the underside of the vehicle, check all mounts and hangers for proper installation. A rubber mount that is overstressed can transmit vibrations as though it were made of steel.

A mount that is too loose will allow excessive movement of the component, contributing to vehicle NVH. You can get a good idea of how tight a mount is by looking at it. Compare the **shape** of the mount with others like it. Any differences between similar mounts could be the source of the complaint.

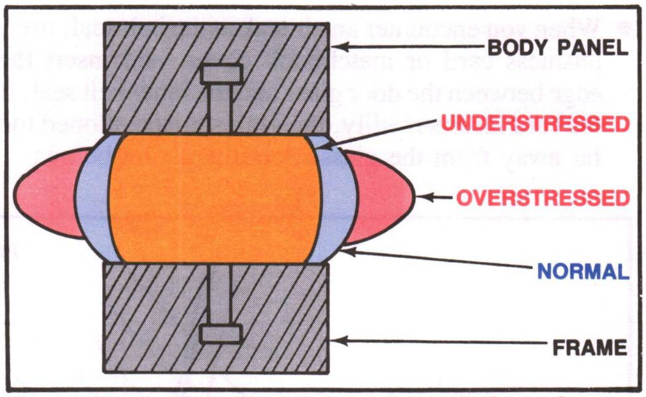


Figure 59 — Checking Proper Installation of Body Mount

REFERENCE SECTION

The following are additional information sources for proper NVH diagnosis. You should familiarize yourself with any that you do not use regularly.

Oasis

Online Automatic Service Information System. This system is used to reference specific vehicles, by Vehicle Identification Number (VIN), to any TSB's related to a particular concern.

Vehicle Shop Manual

Section 18 of the Vehicle Shop Manual covers many of the topics found in this booklet, plus any symptoms or repair procedures specific to the particular model being serviced.

IVLS SYSTEM

Intelligent Video Learning System. Many of the NVH-related repair and diagnostic procedures are presented in Ford's interactive video learning programs. Some of the NVH-related IVLS programs are:

- Anti-lock brake systems
- Engine noise diagnosis
- Vehicle diagnosis
- Rear axle diagnosis and overhaul
- Automotive suspension — basics
- Automotive suspensions — large car and light truck

Video/Text Courses

Many of the topics covered in this booklet are covered in greater detail in either VHS video tape or text programs. The following programs are related to NVH:

TITLE	ORDER	
	NUMBER	ITEM
NOISE, VIBRATION AND HARSHNESS	0910-024 0910-024	IGK TXT
WIND NOISE AND WATER LEAKS	0930-008 0930-008	IGK TXT
BRAKES — STEERING — SUSPENSION AND HALFSHAFTS	1010-002	TXT
FRONT AND REAR SUSPENSION SYSTEMS	1010-110	TXT
REAR AXLE DIAGNOSIS AND OVERHAUL	1500-007 1500-007	UMC VHS
CONVENTIONAL AND TRACTION-LOK INTEGRAL CARRIER REAR AXLES	1500-007 1500-007	IGK TXT
REAR AXLE DIAGNOSIS AND OVERHAUL	1500-007 1500-007	UMC VHS
AXLE-DRIVE SHAFT Diagnosis and Service	1501-203	TXT
FRONT WHEEL DRIVE SYSTEMS Halfshaft and CV Joints	1535-002	TXT
4x4 X FORD	1638-002	TXT
RACK AND PINION POWER STEERING GEARS AND PUMPS	1345-003 1345-003 1345-003	TXT UMC TAPE VHS
POWER STEERING PUMPS AND GEARS	1341-205	TXT

GLOSSARY OF TERMS

Acceleration — This is broken down into three types:

1. Light — An increase in speed at less than 1/2 throttle.

2. Heavy — 1/2 to full throttle increase in speed.

3. WOT — Wide-open throttle.

Ambient Temperature — Surrounding or prevailing temperature. Normally, the temperature in the service area or outdoors, depending on where testing is taking place.

Articulation — Vertical movement of the front driving or rear axle relative to the frame of the vehicle to which they are attached.

Boom — A cycling, rhythmic sound often accompanied by sensation of pressure on the ear drums.

***Bounce** — The vertical motion of a vehicle on its suspension system, front and rear in phase, or a low-frequency "float" or intermediate frequency "kick."

Bound Up — Refers to a stressed, rubber-mounted component that transmits any NVH which would normally be absorbed by the mount. (See Neutralize.)

***Brake Moan** — A low frequency moan or shudder felt in the floor pan and/or steering wheel, usually between 8 and 40 MPH.

Brakes Applied — When vehicle is stationary; service brakes applied with enough force to hold vehicle against acceleration with transmission in gear or drive.

Camber — The attitude of a wheel and tire assembly when viewed from the front of a car. If it leans outward, away from the car, at the top, the wheel is said to have positive camber. If it leans inward, it is said to have negative camber.

Caster — Angle formed between the kingpin axis and a vertical axis as viewed from the side of the vehicle. Caster is considered positive when the top of the kingpin axis is behind the vertical axis.

Center Bearing — Rubber encased, self-centering bearing (truck) used to support driveline at mid-point between coupling shaft and driveshaft; supported by frame crossmember.

***Clunking** — A single-event heavy metallic noise set off due to a sudden extreme movement of a component, such as a driveline or suspension, usually accompanied by a "jarring" sensation.

Coast/Neutral Coast — Engine/transmission taken out of gear with driveshaft/driveline by placing transmission selector in Neutral or by depressing clutch (manual transmission).

CPS — Cycles Per Second.

Cruise — Steady road load, neither accelerating nor decelerating; even pressure on accelerator pedal on level ground.

Controlled Rear Suspension Height — The height at which the components of a particular vehicle should be set when driveline angle measurements are made.

Coupling Shaft — The front portion of a two-piece driveshaft. The front of the shaft is fitted with a single U-joint and the rear of the shaft is supported by the center bearing.

Deceleration — Slowing of vehicle by releasing foot from accelerator at cruise and allowing engine to slow vehicle without application of brakes.

***Drive-Away Shudder** — A strong vibration felt in the floor pan and seat, usually during heavy acceleration; usually present between 0 and 25 MPH.

Driveline — Assembly of shafts, universal joints, splined slip joint and support bearings used to transmit power from transmission output shaft to rear axle input shaft (pinion shaft).

Driveline Angle — Alignment of the transmission output shaft, driveshaft, and rear axle pinion centerline.

***Driveline Vibration** — A vibration felt in the floor pan and/or seats with no visible shaking. It is accompanied by a rumble, "buzzing", hum, drone, or booming noise. Usually felt at speeds over 30 MPH.

Driveshaft (Propeller Shaft/Propshaft) — Rearmost shaft of a driveline which powers the rear axle input shaft (pinion shaft).

GLOSSARY OF TERMS

Drivetrain — Includes all power transmitting components from the engine to the wheels, including clutch/ torque converter, transmission, transfer case, driveline and front/or rear drive axles.

Drone — A deep, sustained murmuring, humming or buzzing sound. (See In-Cab Drone.)

***Drone/Moan** — A low frequency (90-200 Hz.) noise that does not "cycle" or "pulse" rhythmically.

***Engine Accessory Vibration** — A vibration felt whenever the engine reaches a certain RPM. The same vibration is felt during a neutral engine run-up.

Engine Run-Up Test — Operation of engine through normal RPM range with vehicle sitting still, transmission in Neutral. Used for engine and accessory vibration check.

Engine Misfire — One or more cylinders in the engine fails to fire at the proper time.

Excessive — More than specified, or more than acceptable to customer.

Extension Housing Damper — A counterweight attached to an arm on the rear of the transmission extension housing and designed to "soak up" or damp unwanted driveline or powertrain vibrations.

Engine Imbalance — Some component in the engine which is normally smoothly balanced, now causing a perceptible vibration in the vehicle.

Flat Spots (Tires) — Commonly caused by letting vehicle stand while tires cool off. Can be cured by again operating vehicle until tires are warm. Also, regular tire wear patterns in the tire tread resulting from wheel-locked skids.

Float — A cruising drive mode in which throttle setting matches engine speed to road speed, neither accelerating nor decelerating.

Front Driving Axle — Front axle of a vehicle (4x4 models) capable of both transmitting power to the wheels and steering the vehicle.

Gravelly Feel — A grinding or growl in a component, similar to the feel experienced while driving on gravel.

***Grunt** — (On acceleration) A raspy sound and momentary vibration in the floor pan during acceleration or following a braking stop.

***Harshness** — Any harder-than-usual behavior in a component.

***High-Speed Shake** — A visible shaking and bumpy feeling in the steering wheel, accelerator pedal, seats and floor pan during slow acceleration and deceleration. It is a low-frequency vibration that can usually be seen as a front end sheet metal shake, over 45 MPH.

***Humming** — A pure tone at a constant frequency, like that made by an electric motor in an electric fuel pump, window motor, or ABS brake pump motor.

Hz — Hertz (Cycles Per Second).

Imbalance (or Unbalance) — Out of balance; more weight on one side of a rotating component causing shake or vibration.

Inboard — Toward the centerline of the vehicle. (See Outboard)

***In-Cab Drone** — A low-pitched, pulsating rumble inside the cab on any road surface; usually between 30 and 45 MPH.

In-Phase — The in-line relationship between the forward coupling shaft yoke and the driveshaft slip yoke of a two-piece driveline.

Isolate — Separate from the influence of other components.

Known Good — Previously proven reliable or acceptable.

Machine (Brakes) — Recut braking surfaces to specification.

Moan — A low, prolonged sound of distress.

NVH — Noise, Vibration, Harshness.

Neutralize (Normalize) — To return to unstressed position. Used to describe various mounts and exhaust system hangers. (See Bound Up.)

***Nibble/Nibbling** — A low-frequency vibration associated with the steering wheel that is characterized by a slight or partial oscillation of the steering wheel at speeds of 40-50 MPH. It is caused mainly by radial or lateral runout in a wheel/tire axle, tire, or rotor assemblies.

GLOSSARY OF TERMS

Noise — Any unpleasant sound.

Original Position — Position in which a component was mounted or oriented on a vehicle when the condition was reported.

Outboard — Toward the outside of the vehicle, rather than toward the centerline. (See Inboard.)

Parking Brake — Pedal or lever operated brake connected to the rear brake shoes or pads.

Phase — Referring to the rotational positions of the various elements of a driveline.

Pinion Shaft — The input shaft to a driving axle, usually a part of the smaller driving or input gear of a "Ring and Pinion" gear set.

Powertrain — The complete assembly of all components required to transmit power from the engine to the rear wheels. This includes the engine, transmission, driveline and driving axle.

Pumping Feel — A very slow vibration that results in a movement of vehicle components similar to pumping the service brakes slightly.

Radial/Lateral — Radial is the plane of rotation, lateral is at 90° to the plane of rotation.

Ring Gear — The large gear, driven by the pinion gear of a "Ring and Pinion" driving axle gear set. Not applicable to transaxle.

Road Test — Operation of vehicle under conditions designed to recreate the problem condition.

Runout — Out of round or wobble.

Service Brake — Pedal operated four-wheel hydraulic brakes.

***Shake** — A low frequency vibration that usually results in a visible movement of components.

***Shimmy** — The wobble of a front wheel around the steering axis.

***Shudder** — A low-frequency vibration that causes a fore/aft lateral movement; usually felt and not heard. It is usually caused by the powertrain or brake systems.

Slip Yoke (Slip Spline) — Driveshaft coupling device which compensates for changes in shaft length.

***Squeak** — A constant or intermittently-occurring sound that is of high pitch and short duration.

Substitution — Exchange of components for test purposes only.

***Tip-In Moan** — A light moaning sound heard when the vehicle is lightly accelerated, usually between 25-50 MPH.

Tire Deflection — Bending of the body of the tire during rotation.

Tire Force Vibration — Tire vibration caused by variations in the construction of the tire, resulting in a vibration when the tire rotates against the pavement. This condition may be present on perfectly round tires because of variations in the inner construction.

T.I.R. — Total Indicator Runout.

Torque — Turning force expressed in ft.-lb., in.-lb; N•m, etc.

***Torsional Vibration** — A vibration in the seat or floor pan during steady to heavy acceleration or deceleration, usually between 25-45 MPH.

Transaxle — Assembly combining transmission and drive axle gearing. Eliminates ring-and-pinion gearset in transverse-engine applications.

Two-Plane Balance — Radial and lateral balance.

Universal Joints — A double-hinged connection between two shafts which permits one to drive the other although both shafts operate at intersecting angles.

***Vibration** — A constant or variable high-frequency trembling, shaking, or grounding condition that is felt or heard. High-speed vibrations occur at speeds higher than 50 MPH. Low-speed vibrations occur at speeds below 50 MPH.

***Whining** — A pure tone at a constant frequency, usually sharper and higher in pitch than humming.

Whittek Clamp — A screw-type hose clamp.

*Demonstrated with sound, visual representation, or both in the IVLS Program, NVH Vehicle Diagnosis (1989).

NVH WORKSHEET

Dealer: ______________________________ Date: __________

P.A. Code: __________ Order No. __________ Technician: __________

Owner's Name: __________ Address: __________

Phone: H) __________ W) __________

Vehicle Make: __________ Year: __________ Model: __________

VIN: __________ Mileage: __________ Engine: ______ Trans: ______ Axle: ______

OWNER'S DESCRIPTION OF CONCERN:

Did Condition Exist When Vehicle Was New? **Y / N**

How Did Condition Begin? ☐ Gradually Mileage __________

☐ Suddenly Mileage __________

Which Driving Conditions Affect The Vehicle? ☐ Light to Medium Accel ☐ Heavy Accel ☐ Decel (foot off acc. pedal) ☐ Const. Speed

Where Is The Vibration Noticed? ☐ Seat ☐ Steering Wheel ☐ Inst. Panel ☐ Floor ☐ Fenders

Is There A Sound Or Sensation Of Sound? **Y / N**

If Yes, Describe It: ☐ Boom ☐ Drone ☐ Hum ☐ Tip-In-Moan ☐ Whining

Further Descriptions: ______________________________

____

____

VEHICLE INSPECTION:

Tire Size: Front: __________ Tire Mfg: __________

Rear: __________ Tire Mfg: __________

Tire Pressure: LF: ______ RF: ______ LR: ______ RR: ______

Tire Condition: LF: ______ RF: ______ LR: ______ RR: ______

Body Damage Evident? **Y / N**

If Yes, Where? __________

ROAD TEST:

Vibration Occurs At ______ to ______ MPH, at ______ RPM

Indicates: ☐ Tire/Wheel ☐ Pinion Angle ☐ Driveline

☐ Tip-In-Moan ☐ Engine/Acc. ☐ Other

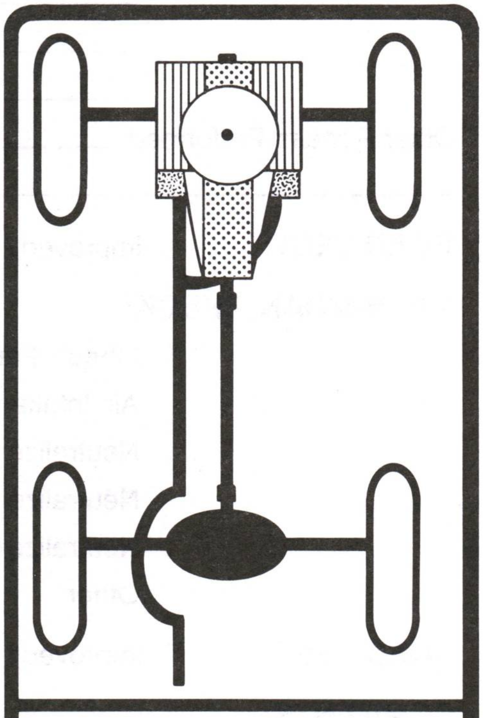
If "Other", Specify: __________

WHEEL/TIRE CHECK:

Max. Runout Allowed Tire/Wheel ____" radial ____" lateral

Wheel Only: ____" radial ____" lateral

Runouts Measured:		LF	RF	LR	RR
Tire and Wheel:	Radial/	____"	____"	____"	____"
	Lateral/	____"	____"	____"	____"
Wheel Only:	Radial/	____"	____"	____"	____"
	Lateral/	____"	____"	____"	____"



Record tire pressure, wear, and any other potential problem areas directly on the drawing.

ROAD TEST: Improved? **Y / N** Vehicle Acceptable? **Y / N**

COMMENTS: ______________________________

____

Ford Parts and Service Division
Technical Training Department

DRIVELINE BALANCE:

Maximum Runout Allowed: ______" Runouts Measured **Front** ______"

Middle ______" **Rear** ______"

Reindex Driveshaft? **Y / N** Balance Driveshaft? **Y / N**

Other Repairs Performed: ______

ROAD TEST: Improved? **Y / N** Vehicle Acceptable? **Y / N**

PINION ANGLE:

	Spec	**Actual**	**Repair Performed**
Ride Height:	______	______	______
Pinion Angle:	______	______	______

ROAD TEST: Improved? **Y / N** Vehicle Acceptable? **Y / N**

Neutral Run-up Test: Vibration Evident? **Y / N** If Yes: ___ to ___ RPM.

ENGINE ACCESSORY CHECK:

Visual Inspection/Comments: ______

Component Isolation:

Belt Removed	**Result**
______	______
______	______
______	______
______	______

Other Repairs Performed: ______

______

ROAD TEST: Improved? **Y / N** Vehicle Acceptable? **Y / N**

TIP-IN-MOAN CHECK:

Check Performed	**Result**
Air Intake	______
Neutralize Exhaust	______
Neutralize Converter	______
Neutralize Mounts	______
Other	______

ROAD TEST: Improved? **Y / N** Vehicle Acceptable? **Y / N**

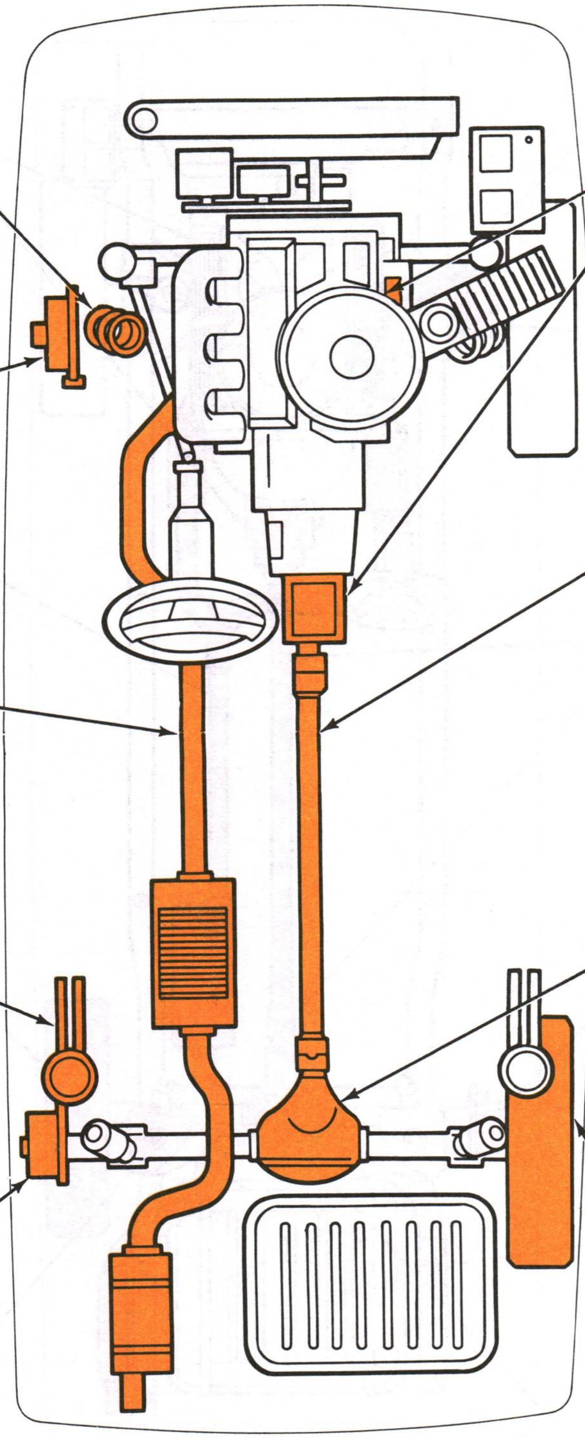
COMMENTS: ______

______

______

DIAGNOSTIC LOCATOR INDEX

UNITIZED BODY, REAR WHEEL DRIVE CAR



FRONT SUSPENSION WEAR, DAMAGE, MISALIGNMENT.

HARSHNESS, NOISE.

BRAKE ROTOR FLANGE, PILOT OR WHEEL BOLT RUNOUT. WHEEL BEARING ROUGHNESS.

HIGH SPEED SHAKE, NOISE.

EXHAUST SYSTEM BINDING, GROUNDING OR ALIGNMENT

BOOM OR TIP-IN MOAN.

REAR SUSPENSION WEAR, BINDING OR MISALIGNMENT.

HARSHNESS.

BRAKE DRUM IMBALANCE AXLE SHAFT END PLAY, AXLE FLANGE FACE, PILOT OR WHEEL BOLT RUNOUT.

HIGH SPEED SHAKE OR AXLE CLUNK.

ENGINE, MOUNTS, ACCESSORIES, AIR CLEANER, BELTS.

TIP-IN MOAN, ACCESSORY. VIBRATION, HARSHNESS.

DRIVESHAFT BALANCE, RUNOUT, ANGLE OR U-JOINT BINDING.

BOOM OR VIBRATION.

DRIVE AXLE NOISE OR VIBRATION,

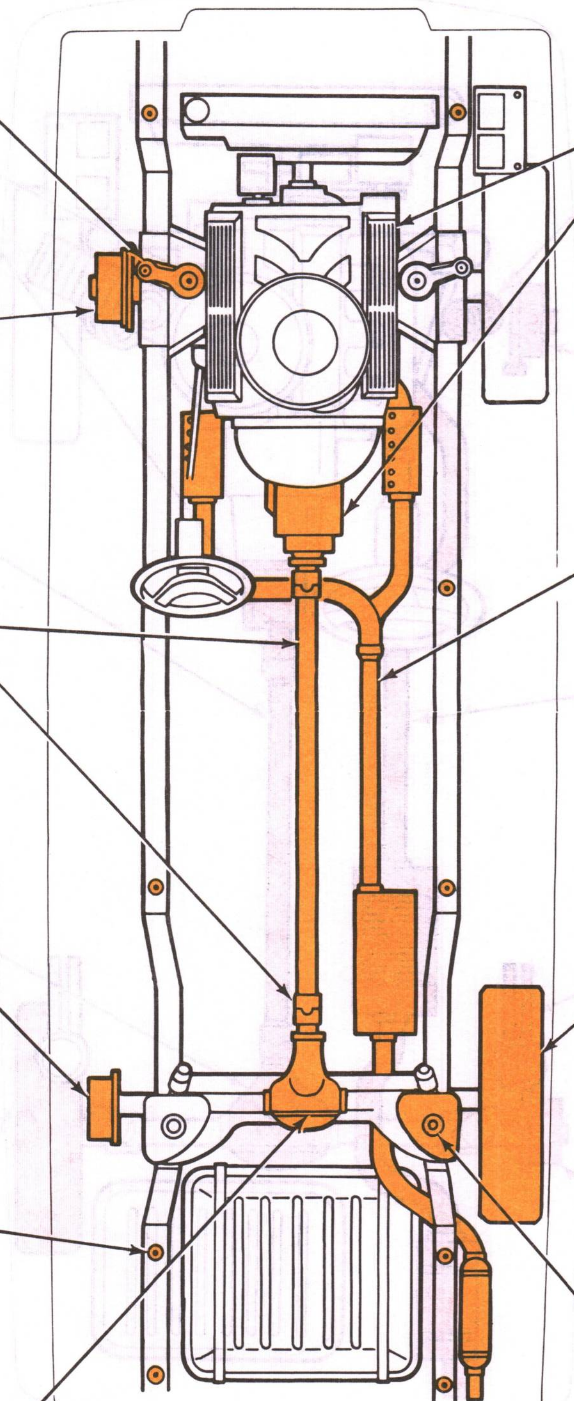
DRIVELINE VIBRATION.

WHEEL AND TIRE IMBALANCE, NON-UNIFORMITY, INFLATION AND RUNOUT.

HIGH SPEED SHAKE, HARSHNESS.

DIAGNOSTIC LOCATOR INDEX

NON-UNITIZED BODY, CAR



FRONT SUSPENSION WEAR, DAMAGE, MISALIGNMENT.

NOISE, HARSHNESS.

FRONT WHEEL BEARING ROUGHNESS, MISADJUSTMENT. BRAKE ROTOR FLANGE, PILOT OR BOLT CIRCLE RUNOUT.

NOISE, HIGH SPEED SHAKE.

DRIVESHAFT ANGLE, BALANCE, INDEXING, RUNOUT, U-JOINT SEIZURE, IMPROPER INSTALLATION.

NOISE, DRIVELINE VIBRATION.

BRAKE DRUM IMBALANCE AXLE SHAFT END PLAY, AXLE FLANGE, PILOT OR BOLT CIRCLE RUNOUT, WHEEL BEARING ROUGHNESS.

NOISE, HIGH SPEED SHAKE.

BODY MOUNTS MISALIGNED, TORN, GROUNDED, MISSING.

NOISE, HARSHNESS.

ENGINE, MOUNTS, ACCESSORIES, AIR CLEANER, TORQUE CONVERTER, BELTS. BINDING, LOOSENESS, MISALIGNMENT, WEAR OR DAMAGE.

TIP-IN MOAN, BOOM, VIBRATION.

EXHAUST SYSTEM GROUNDING, BINDING.

TIP-IN MOAN, BOOM.

WHEEL AND TIRE RUNOUT, IMBALANCE, NON-UNIFORMITY INFLATION.

NOISE, HIGH SPEED SHAKE.

REAR SUSPENSION WEAR, DAMAGE, BINDING.

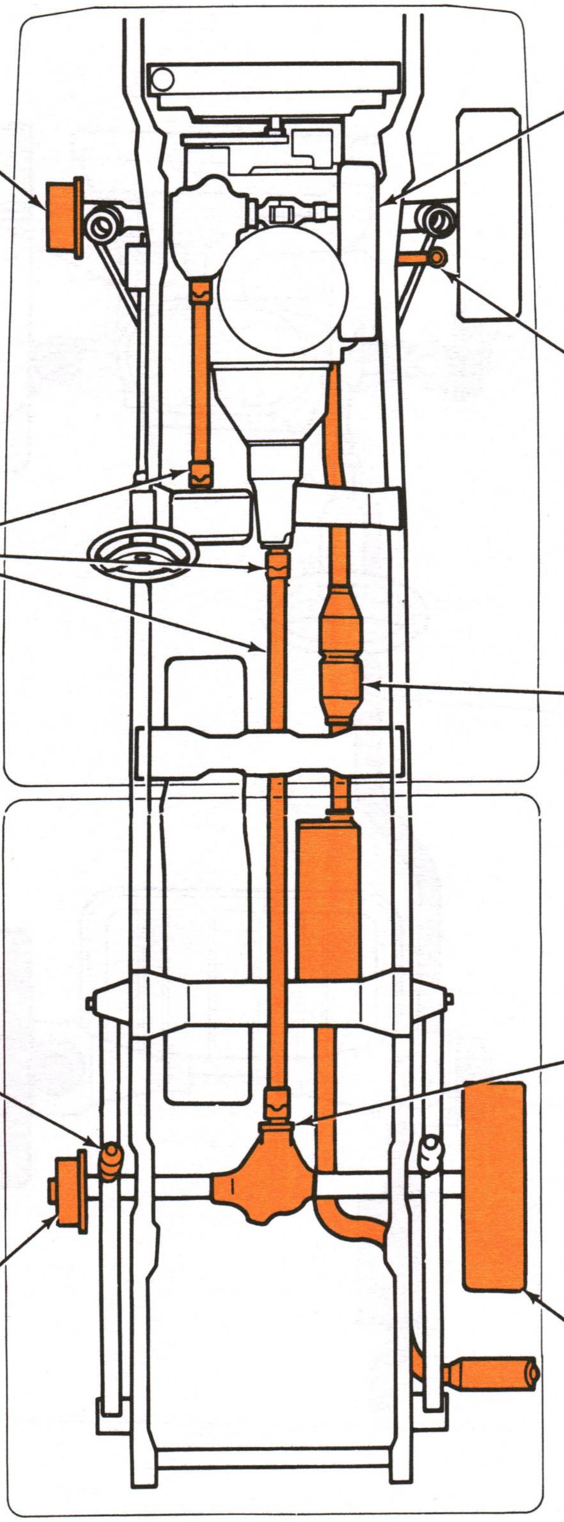
NOISE, HARSHNESS.

DRIVE AXLE BEARING ROUGHNESS, RING GEAR RUNOUT, EXCESSIVE BACKLASH.

NOISE, DRIVELINE VIBRATION.

DIAGNOSTIC LOCATOR INDEX

LIGHT TRUCK



WHEEL BEARING ROUGHNESS, MISADJUSTMENT. BRAKE ROTOR FLANGE, PILOT OR BOLT CIRCLE RUNOUT. AXLE SHAFT U-JOINT BINDING (4x4).

NOISE, HIGH SPEED SHAKE, HARSHNESS.

ENGINE, MOUNTS, ACCESSORIES, AIR CLEANER, TORQUE CONVERTER, BELTS. BINDING, LOOSENESS, MISALIGNMENT, WEAR OR DAMAGE.

TIP-IN MOAN, BOOM, VIBRATION.

FRONT SUSPENSION WEAR, DAMAGE, MISALIGNMENT.

NOISE, HARSHNESS.

DRIVESHAFT RUNOUT, BALANCE, ANGLE. U-JOINT SEIZURE, WEAR. DRIVELINE

VIBRATION.

EXHAUST SYSTEM GROUNDING, BINDING.

TIP-IN MOAN, NOISE.

REAR SUSPENSION WEAR, DAMAGE, MISALIGNMENT, BINDING.

NOISE, HARSHNESS.

DRIVE AXLE BEARING ROUGHNESS, RING GEAR RUNOUT, EXCESSIVE BACKLASH.

NOISE, DRIVELINE VIBRATION.

WHEEL BEARING ROUGHNESS, MISADJUSTMENT. AXLE SHAFT END PLAY, AXLE FLANGE, PILOT OR BOLT CIRCLE RUNOUT.

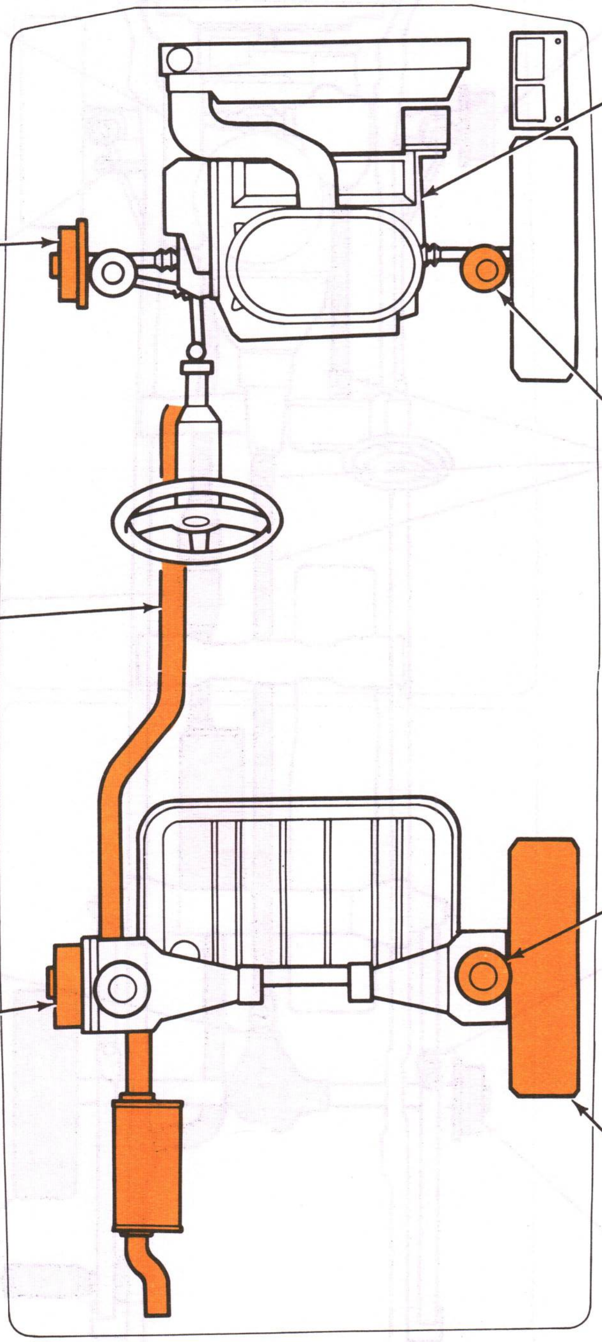
NOISE, HIGH SPEED SHAKE.

WHEEL AND TIRE IMBALANCE, RUNOUT, NON-UNIFORMITY, INFLATION.

NOISE, HIGH SPEED SHAKE.

DIAGNOSTIC LOCATOR INDEX

UNITIZED BODY, FRONT WHEEL DRIVE CAR



ENGINE, MOUNTS, ACCESSORIES, AIR CLEANER, TRANSAXLE, BELTS. BINDING, LOOSENESS, MISALIGNMENT, WEAR OR DAMAGE.

VIBRATION, NOISE.

FRONT WHEEL BEARING ROUGHNESS, ROTOR FLANGE, PILOT OR BOLT CIRCLE RUNOUT, CV JOINT ROUGHNESS.

NOISE, VIBRATION.

FRONT SUSPENSION WEAR, MISALIGNMENT, BINDING.

NOISE, HARSHNESS.

EXHAUST SYSTEM BINDING, GROUNDING.

TIP-IN MOAN, BOOM.

REAR SUSPENSION MISALIGNMENT, WEAR, BINDING.

NOISE, HARSHNESS.

REAR WHEEL BEARING ROUGHNESS, MISADJUSTMENT, DRUM FACE, PILOT AND BOLT CIRCLE RUNOUT.

NOISE AND VIBRATION.

WHEEL AND TIRE RUNOUT, IMBALANCE, NON-UNIFORMITY, INFLATION, DIAGONAL TIRE WEAR.

HIGH SPEED SHAKE, HARSHNESS.

NOTES

WE SUPPORT VOLUNTARY TECHNICIAN CERTIFICATION

MAY 1989
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CTP-1989-5
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